INSTRUCTION MANUAL

MODEL 1500A RECEIVER

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F R E D E R I C K   E L E C T R O N I C S   C O R P O R A T I O N
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ERRATA SHEET
MODEL 1500A

REFERENCE	CORRECTION
Figure 7-2. Parts List	1. Item 37 should read JSR 325-30-5106-NXE-AAG switch assembly ITT, quantity 1 (FEC part no. 723956). 2. Delete item 38. ECN 2036 11-26-75 DJK
Figure 7-8. Parts List	Change part number of item 3 to HT10MA/550.
Figure 6-3	Add 5-50 PF values to C1 thru C6 on schematic of board N0736.
Figure 7-3	Change part number of item 15 to HT10KA/29.

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SECTION I

INTRODUCTION

1.1 PURPOSE OF EQUIPMENT

The Frederick Electronics Corporation (FEC) Model 1500A Receiver provides optimum reception of FSK signals in the range of 10 kHz to 29 MHz. The Receiver is crystal-controlled and designed for use with an external FSK Demodulator such as the FEC Model 1200. When used with the Model 1200, the receiver accepts AGC information from the demodulator and maintains an ideal environment for the demodulator's detectors and patented Decision Threshold Computer.

The Receiver preselects the desired FSK signal at its antenna input circuit, converts this signal first to a 9 MHz IF and then to an audio frequency signal. Separate amplifier stages change the audio signal into a form suitable for driving both an external demodulator and a monitoring device. The output for the demodulator is rated at a maximum of 10 dbm; the monitoring output is rated at approximately 1/4 watt into a 16-ohm load.

The receiver utilizes highly selective filter circuits, a low-noise beam deflection mixer, and a special product detector to reduce the effects of cross modulation to a level substantially below that of conventional communications receivers.

Frequency tuning of the receiver is accomplished by selecting different crystals which are plugged into sockets on the front panel. As many as six crystals can be plugged in at any one time. An optional frequency synthesizer further simplifies tuning by providing crystal control on any frequency within the receiver's range. In this case, frequency selection is effected by dialing the desired frequency.

A built-in noise generator allows the operator to peak the receiver for optimum sensitivity at the tuned frequency.

1.2 PHYSICAL DESCRIPTION

The Model 1500A Receiver contains plug-in IF, Audio/AGC, and Power Supply printed circuit boards, and fixed Preselector, Mixer, and Local Oscillator printed circuit boards. Front panel items include an S-meter, six crystal sockets and associated trim capacitors, a headphone jack, and various controls and switches. The receiver, conveniently packaged for mounting in a standard 19-inch equipment rack, is 19-inches wide, 17-inches deep, and 1-3/4 inches high. The unit weighs approximately 10 pounds.

1.3 SPECIFICATIONS

Specifications for the receiver are shown in table 1-1.

Table 1-1. Specifications

ANTENNA INPUT	Nominal 50 ohms, unbalanced.
NOISE GENERATOR	Approximately 1 microvolt in the standard 2.1 kHz bandwidth over range of receiver (injected at antenna terminal).
SENSITIVITY	10 kHz to 550 kHz: 1 microvolt for 10 db signal plus noise-to-noise ratio. 1.7 MHz to 29 MHz: 1 microvolt for 20 db signal plus noise-to-noise ratio.
*FREQUENCY RANGE	10 kHz to 550 kHz and 1.7 MHz to 29 MHz (excluding the IF channel of 9.000 MHz) in 6 bands.
**SELECTIVITY	2.1 kHz bandwidth at 6 db. 3.6 kHz bandwidth at 60 db (Output center frequency: 2.5 kHz.)
IMAGE RESPONSE	Minimum of 50 db down.
ADJACENT CHANNEL INTERFERENCE THRESHOLD	60 db at 10 kHz from center frequency. 100 db at 50 kHz from center frequency.
INTERMEDIATE FREQUENCY	9 MHz.
AUTOMATIC GAIN CONTROL	Internal: Fast or slow release. External: Slow release.
RECEIVER OUTPUT	600 ohms, variable up to +10 dbm.
MONITOR OUTPUT	Speaker: 16 ohms, 1/4 watt, or headphones.
POWER REQUIREMENTS	115/230 volts, ac, 47 to 63 Hz. (Internal wiring change needed for 230 volt operation.)
TEMPERATURE RANGE	0° to 50° C.
DIMENSIONS	Depth: 17 inches Width: 19 inches Height: 1-3/4 inches

*Signals cannot be received at 9.000 MHz, 13.500 MHz, 18.000 MHz, 22.500 MHz, or 27.000 MHz because of harmonic interference.

**Selectivity is determined by crystal filter/audio filter. Center frequency of passband is determined by BFO crystal frequency. The Receiver is available in a range of selectivities and center frequencies as requested by user. It is not recommended that field modifications be attempted for the purpose of varying the specifications.

SECTION II

INSTALLATION

2.1 INSPECTION

After removal from its shipping container the unit should be inspected. If any damage is found, file a written claim with the shipping agency. Send a copy of this claim to Frederick Electronics Corporation, P.O. Box 502, Frederick, Maryland 21701.

2.2 POWER REQUIREMENTS

The Receiver is shipped ready to operate directly on 105-130 volt, 47-63 Hz ac current. Power is applied to the receiver by plugging its power cord into an ac outlet. Provision is also made in the receiver for operation from a 230-volt source by repositioning switch S1 located on power supply board N0724.

CAUTION

Switch must be in correct position before the receiver can operate on 230 volts. Serious damage will result if the receiver is connected to 230 volts without this change.

2.3 MOUNTING

The Receiver is designed to mount in a standard 19-inch equipment rack. A vertical rack space of 1-3/4 inches is required.

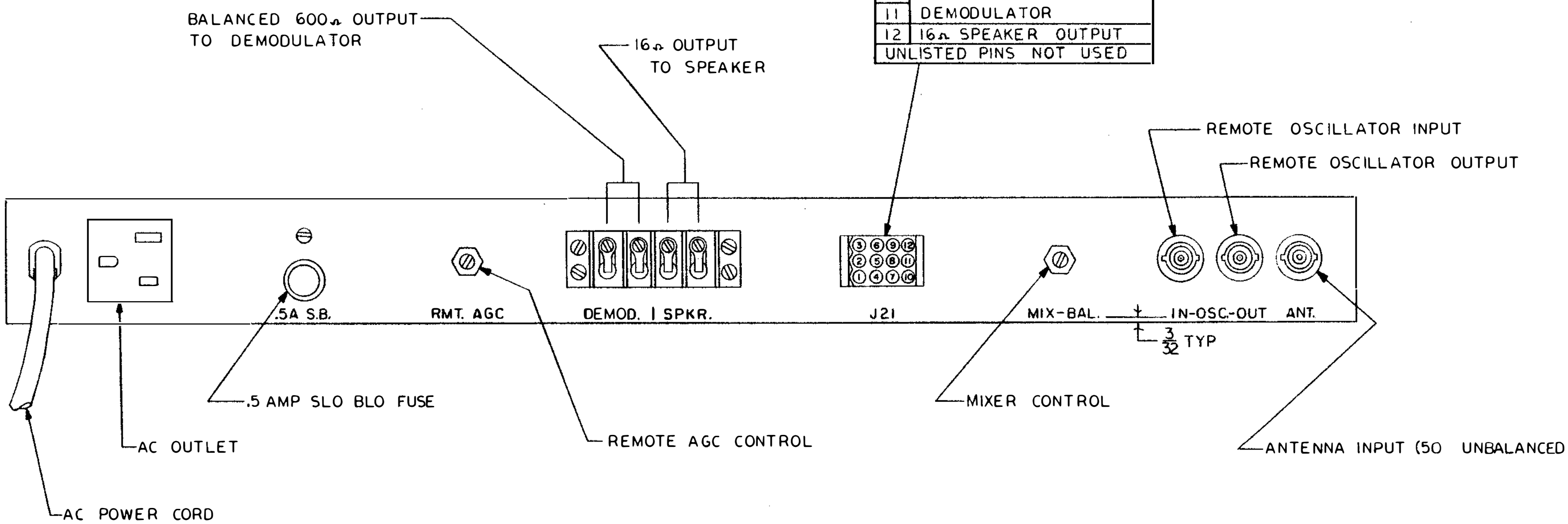
2.4 ANTENNA

The RF signal input circuit to the receiver is designed to operate from any antenna having a transmission line impedance of 50 ohms, unbalanced. Antenna connections are made to a BNC connector located at the rear of the receiver. Detailed information on the subject of antennas and transmission lines is found in the Radio Amateur's Handbook and the A.R.R.L. Antenna Book, both published by the American Radio Relay League, Newington, Connecticut, U.S.A.

2.5 REAR TERMINAL BOARD CONNECTIONS

Figure 2-1 identifies all rear panel connections on the receiver.

PIN	FUNCTION
4	GROUND
5	
6	EXTERNAL AGC COMMON
7	EXTERNAL AGC SPACE INPUT
8	EXTERNAL AGC MARK INPUT
9	GROUND
10	BALANCED 600Ω OUT TO
11	DEMODULATOR
12	16Ω SPEAKER OUTPUT
UNLISTED PINS NOT USED	



NOTES

1. STENCIL APPROXIMATELY AS SHOWN 1/8 HIGH.

Figure 2-1. Rear Panel Connections

2.6 MONITOR OUTPUT

2.6.1 SPEAKER

Two outputs for driving external permanent magnet speakers are provided at the rear of the receiver. One output is at terminals 1 and 2 (ground) of TB1. The other output is at pins 9 (ground) and 12 of J1. This latter output is convenient when a single plug is used to interconnect the receiver and demodulator. Speaker voice coil impedances can be almost any standard value, although maximum efficiency will be obtained with 16-ohm impedances.

2.6.2 HEADPHONES

A headphone jack labeled MONITOR is located on the receiver front panel. This jack is wired so that the speaker or speakers are disconnected when headphones are plugged in. Headphone impedance is not critical, and any commercially available headphones should function satisfactorily.

SECTION III

OPERATION

3.1 GENERAL

This section contains complete operating instructions for the Receiver. Included are a tabular list of each control and indicator (table 3-1), information on the use of the controls and indicators, procedures for tuning the receiver, and special instructions for operating the receiver with a Model 1200 FSK Demodulator.

Table 3-1. Controls and Indicators

Power ON switch	Controls ac power to receiver.
Power ON lamp	Lights to indicate that power is applied to equipment.
MONITOR jack	Provides headphone reception of received signal.
MONITOR LEVEL control	Adjusts audio level at speaker terminals and MONITOR jack.
OUTPUT LEVEL control	Adjusts audio level to external demodulator.
RF GAIN control	Varies gain of mixer and IF amplifier stages by setting AGC threshold.
AGC SLOW FAST RMT switch	<u>SLOW position</u>: Selects internal AGC with slow release time constant. <u>FAST position</u>: Selects internal AGC with fast release time constant. <u>RMT position</u>: Selects external AGC input and internal slow release time constant.
OSC TRIM -/+ control	Permits crystal frequency to be "pulled" slightly to either side of channel for fine tuning adjustments.
CRYSTAL switch	Selects any one of six crystal sockets or remote (R) jack to determine receiver operating frequency.

Table 3-1. Controls and Indicators (cont.)

CRYSTAL sockets	Six standard HC6-U crystal sockets for receiving any parallel-resonant 32 pf crystal in range of receiver. Each socket has an associated trim capacitor located above the sockets.
BAND switch	Selects frequency range of receiver tuning. A (black) position: 1.7 to 3.5 MHz B (green) position: 3.5 to 7 MHz C (yellow) position: 7 to 13 MHz D (red) position: 13 to 20 MHz E (blue) position: 20 to 29 MHz L (white) position: 10 kHz to 550 kHz
MHz (Preselector) control	Used in conjunction with BAND switch to peak preselector tuning. Has approximate frequency settings within each selected band. Frequency settings are color-coded to agree with BAND switch positions. (This control is not used on low frequency band.)
S-UNITS meter	Indicates accuracy of tuning and relative strength of received signals. Meter is calibrated in S-units from 1 to 9, and in decibels above S9 to +90 db.
Noise pushbutton switch (Located below S-UNITS meter)	Activates noise generator and allows receiver to be peaked for optimum reception.
RMT AGC control (rear panel)	Adjusts remote AGC gain.
MIX-BAL control	Adjusts mixer balance.

3.2 USE OF CONTROLS

3.2.1 BAND SELECTOR SWITCH

The BAND selector switch permits the operator to cover the six different frequency ranges of the receiver. This switch is used in conjunction with the MHz preselector control to tune the receiver to a specific frequency. (There is no preselector control setting for the L band.) Each band of the selector switch is identified by a different-colored letter of the alphabet (A through L). Settings of the MHz control are color-coded to agree with the band selected. In this manner, the operator immediately knows the band he has selected and the approximate frequency setting within that band.

One point to remember in selecting bands is this: If the desired frequency coincides with the dividing point between bands, always choose the band which produces the higher S-meter reading.

3.2.2 MHz CONTROL

The MHz control is a variable tuning control that peaks the preselector tuning. After a particular band is selected by the BAND switch, the MHz control is adjusted to the approximate frequency being used. This control is inoperative on the L band. Frequency settings indicated on the control are not intended to pinpoint the exact operating frequency, but they will narrow down the tuning until the operator can zero-in on the desired frequency. The S-meter is a valuable aid in peaking the MHz control.

3.2.3 S-METER

The S-meter provides a visual means of determining whether or not the MHz preselector control is properly tuned, as well as an indication of relative signal strength. To the experienced operator, the S-meter can provide valuable information about receiving conditions.

The S-meter is calibrated in S-units from 1 to 9, and in decibels above S9 to +90 db. Readings on the S-meter will be correct only when the RF GAIN control is at maximum sensitivity (fully clockwise).

3.2.4 NOISE SWITCH

The noise pushbutton switch (located below the S-meter) activates a noise generator which permits the receiver to be peaked at the preselector for optimum reception. No signal other than the noise signal is necessary for this adjustment. After the MHz preselector is set to the approximate frequency desired, the noise pushbutton should be depressed and held while the MHz control is adjusted for maximum reading on the S-meter.

NOTE

> If care is not taken, the preselector may be peaked at an image frequency. To avoid this condition, make sure that the MHz preselector control is set to the desired frequency.

The noise generator signal may be used for emergency alignment of the receiver when no other signal source is available. In addition, the noise generator provides a test for receiver operation, since receiver failures (including local oscillator failure) will result in no noise output when the pushbutton is depressed.

3.2.5 RF GAIN CONTROL

The RF GAIN control varies the gain of the mixer and IF amplifier stages by setting a fixed threshold in the AGC circuits. Maximum gain is obtained with the control rotated fully clockwise.

3.2.6 CRYSTAL SELECTOR SWITCH

The CRYSTAL selector switch is a 7-position switch that permits the operator to choose the exact frequency of operation. Associated with the numbered positions of the switch are correspondingly numbered crystal sockets and trim capacitors. To change frequency, the operator first inserts the proper crystal into any empty socket. Second, the operator must tune in the signal and adjust the crystal trim capacitor (located directly above the crystal socket) for a maximum reading on the S-meter (see paragraph 3.3). The R position of this switch enables the receiver to accept the input from an external synthesizer.

Table 3-2 shows the relationship between received signal frequency and crystal local oscillator frequency. Table 3-2 also lists certain frequencies that cannot be received by the Model 1500A because of harmonic interference.

Table 3-2. Signal Frequency Vs. Crystal Frequency

BAND	FREQUENCY RANGE	OSC. CRYSTAL RANGE (MHz)	NON-RECEIVABLE FREQUENCIES (MHz)
A	1.7 MHz-3.5 MHz	10.7 - 12.5	None
B	3.5 MHz-7 MHz	12.5 - 16	None
C	7 MHz-13 MHz	16 - 22	9.000
D	13 MHz-20 MHz	4 - 11	13.500, 18.000
E	20 MHz-29 MHz	11 - 20	22.500, 27.000
L	10 kHz-550 kHz	9.010-9.550 MHz	None

Crystals used should meet the following specifications:

Mode of oscillation: 4,000-22,000 kHz, AT cut
Shunt capacitance: 7 Pf (maximum)
Resistance: 75 to 25 ohms
Maximum drive: 10 milliwatts (4,000-9,999 kHz)
4 milliwatts (10,000-22,000 kHz)
Load capacity: 32 Pf
Temperature Tolerance: -10^{o} to $+60^{o}$ C within 0.0005%
Holder: HC6/U

3.2.7 OSC TRIM CONTROL

The OSC TRIM control permits the frequency of the crystal local oscillator to be varied slightly around its center frequency for optimum tuning of the received signal. (Recall, that each crystal is trimmed individually when it is initially installed and the OSC TRIM control is centered for this adjustment.) In general, the amount of variation possible is proportional to the frequency of the crystal selected. Normally, the receiver is tuned with the OSC TRIM control set to its center position (indicated by a vertical line). The OSC TRIM control is then used to optimize the demodulator input signal by rubbering the IF frequency slightly. Extreme accuracy can only be obtained with the aid of the tuning indicator associated with the external demodulator. For example, if a Model 1200 FSK demodulator is being used, the OSC TRIM control is rotated + and - from the vertical line until the demodulator's tuning meter reads maximum. The Model 1200 instruction manual explains this tuning procedure in more detail.

3.2.8 AGC SWITCH

The AGC switch selects either an internally generated automatic gain control signal or externally generated information from which AGC signals are derived. In either case, the gain of the receiver is automatically regulated in inverse proportion to the strength of the received signal. The overall result is that the output level of the receiver tends to remain constant regardless of variations in input signal strength.

The SLOW position of the AGC switch provides a fast attack and a slow release time constant for the reception of FSK signals. Slow AGC is desirable for normal receiving conditions, since it inserts just enough delay to suppress noise buildup during momentary absences of either the mark or space tone.

The FAST position of the AGC switch provides a fast attack and fast release time constant. Fast AGC is more beneficial when receiving conditions include rapid signal fades. One objectionable feature of fast AGC is that noise buildup can occasionally become excessive. This is because the receiver recovers more rapidly and allows noise to appear in the output. At such times, little can be done to improve conditions at the receiver.

The RMT position of the AGC switch selects mark and space input signals from an external demodulator such as the FEC Model 1200. An AGC control voltage is then derived from these external signals.

3.2.9 OUTPUT LEVEL CONTROL

The OUTPUT LEVEL control adjusts the level of the audio amplifier feeding the external FSK Demodulator. Maximum output is obtained with the control rotated fully clockwise.

3.2.10 MONITOR LEVEL

The MONITOR LEVEL control adjusts the level of the audio amplifier feeding the headphone jack and external speaker terminals. Maximum output is obtained with the control rotated fully clockwise.

3.3 OPERATING THE RECEIVER

Before operating the receiver, make sure that it is properly installed as described in section II of this manual. The receiver can now be tuned to any frequency within its range by means of the following step-by-step procedures:

1. Insert crystal of proper frequency into any unused socket on front panel. (Refer to table 3-2.)
2. Set CRYSTAL switch to match socket number selected above.
3. Set power switch to ON. Pilot lamp will light indicating that receiver is operative.
4. Rotate RF GAIN control fully clockwise. S-meter needle will drop to zero.
5. Rotate MONITOR LEVEL control clockwise until a low volume hiss is heard from speaker or headphones.
6. Set AGC switch to SLOW.
7. Rotate OSC TRIM control to center line.
8. Set BAND switch to band containing desired frequency. If band L is being used, proceed directly to step 10 below. If bands A through E are being used, proceed to step 9.
9. Rotate MHz preselector control to number approximating desired frequency. Tune to signal by rotating MHz control for maximum reading on S-meter. With a small screwdriver adjust crystal trim capacitor for a maximum reading on S-meter. After crystal trimmer is adjusted once for a given frequency the Receiver can be returned to the correct frequency by centering the OSC TRIM control, selecting the crystal, and rotating the MHz control for a maximum reading on the S-meter.

NOTE

> Avoid peaking receiver at an image frequency by making sure that the MHz control is set to the scale reading corresponding to the desired frequency. Although it will be necessary to rock the MHz control back and forth about the indicated frequency, the final scale setting will always be fairly close to the desired frequency.

10. With a strong signal present on the frequency just tuned, rotate OUTPUT LEVEL control clockwise until receiver provides a zero dbm signal into 600-ohm line of external demodulator. The demodulator should have some type of level meter to indicate zero dbm. When this point is reached, the demodulator's level control can be used to control its gain.

11. Adjust OSC TRIM control for a maximum reading on demodulator tuning meter. (See paragraph 3.2.7.) After this adjustment the receiver is properly tuned.

3.4 OPERATION WITH THE MODEL 1200

To operate the receiver with a Model 1200 FSK Demodulator, the tuning procedures in paragraph 3.3 are modified as stated below. A thorough familiarity with the Model 1200 is an essential requisite for performing these operations smoothly and efficiently. The operator should refer to the Model 1200 instruction manual, and especially to the flow chart in figure 3-1 of that manual.

Before operating the receiver with a Model 1200, make sure that the receiver is properly installed as described in section II of this manual. Next, proceed as follows:

1. Insert crystal of proper frequency into any unused socket on front panel of receiver. (Refer to table 3-2.)
2. Set CRYSTAL switch to match socket number selected above.
3. Set receiver power switch to ON. Pilot lamp will light indicating that receiver is operative.
4. Perform steps 3 and 4 in Model 1200 flow chart.
5. Rotate receiver RF GAIN control fully clockwise. S-meter needle will drop to zero.
6. Perform step 6 in Model 1200 flow chart.
7. Rotate receiver OSC TRIM control to center line.
8. Set receiver BAND switch to band containing desired frequency. If band L is being used, proceed directly to step 10 below. If bands A through E are being used, proceed to step 9.
9. Rotate MHz preselector control to number approximating desired frequency. Tune to signal by rotating MHz control for maximum reading on S-meter. If no signal is present, depress and hold noise pushbutton while rotating MHz control for maximum reading on S-meter.

NOTE

> Avoid peaking receiver at an image frequency by making sure that the MHz control is set to the scale reading corresponding to the desired frequency. Although it will be necessary to rock the MHz control back and forth about the indicated frequency, the final scale setting will always be fairly close to the desired frequency.

10. Rotate receiver OUTPUT LEVEL control fully clockwise.
11. Fine tune receiver by performing step 18 in Model 1200 flow chart. Use OSC TRIM control for tuning.
12. Set receiver AGC switch to RMT. Set Model 1200 LIMITER and METER switches to OUT and LEVEL positions, respectively.
13. On rear panel of receiver, adjust RMT AGC control to obtain a meter reading on the Model 1200 approximately halfway between center and zero dbm. This completes the tuning procedure.

SECTION IV

THEORY OF OPERATION

4.1 FUNCTIONAL DESCRIPTION

A functional block diagram of the Model 1500A Receiver is shown in figure 4-1. Frequency shift keying (FSK) signals in the range of 10 kHz to 550 kHz and 1.7 MHz to 29 MHz are routed from the antenna to the appropriate section of a 6-band preselector. The preselector is fixed-tuned on the 10 kHz to 550 kHz band, and tunable on all other bands. A built-in noise generator allows the operator to peak the preselector in the absence of a signal. Output signals from the preselector are connected to a beam deflection mixer circuit.

The beam deflection mixer circuit combines the preselected signal with a local crystal oscillator signal to produce a 9 MHz IF signal. Inherent characteristics of the mixer circuit provide a signal output which is low in noise content and virtually free of cross modulation.

Local oscillator crystals are selected so that the difference between the desired input signal and the crystal frequency is always 9 MHz. A front panel OSC TRIM control provides fine adjustment of the oscillator frequency. To facilitate receiver tuning, provision is made at the front panel to accept up to six plug-in crystals for any specified frequency within the 10 kHz to 29 MHz range. Crystals are selected by a rotary switch; an additional switch position permits the output of a remote frequency synthesizer to be selected. The synthesizer provides crystal control on any frequency within the receiver's range; tuning is accomplished by merely dialing the frequency.

The 9 MHz IF output from the beam deflection mixer circuit is passed through a 6-pole crystal-lattice filter. This filter has a center frequency of 9 MHz, and provides sharp skirt selectivity to produce a 2.1 kHz bandpass. The filter output is amplified and connected to a product detector.

The product detector converts the 9 MHz IF signal to a 2.5 kHz audio signal. It does this by heterodyning the 9 MHz IF signal with a beat frequency oscillator (BFO) signal to produce a difference frequency of 2.5 kHz. The BFO injection signal is supplied by one of two crystal oscillators, as determined by the frequency band being received. The resultant 2.5 kHz output from the product detector is routed to a 3-pole bandpass filter.

The 3-pole bandpass filter has a center frequency of 2.5 kHz, and provides sharp skirt selectivity to produce an ideal bandpass for FSK signals. A high-gain, low-level audio stage suitably amplifies the 2.5 kHz signal for driving an audio distribution amplifier. This latter amplifier distributes the 2.5 kHz signal to an audio output amplifier, an audio monitor amplifier, and AGC circuits.

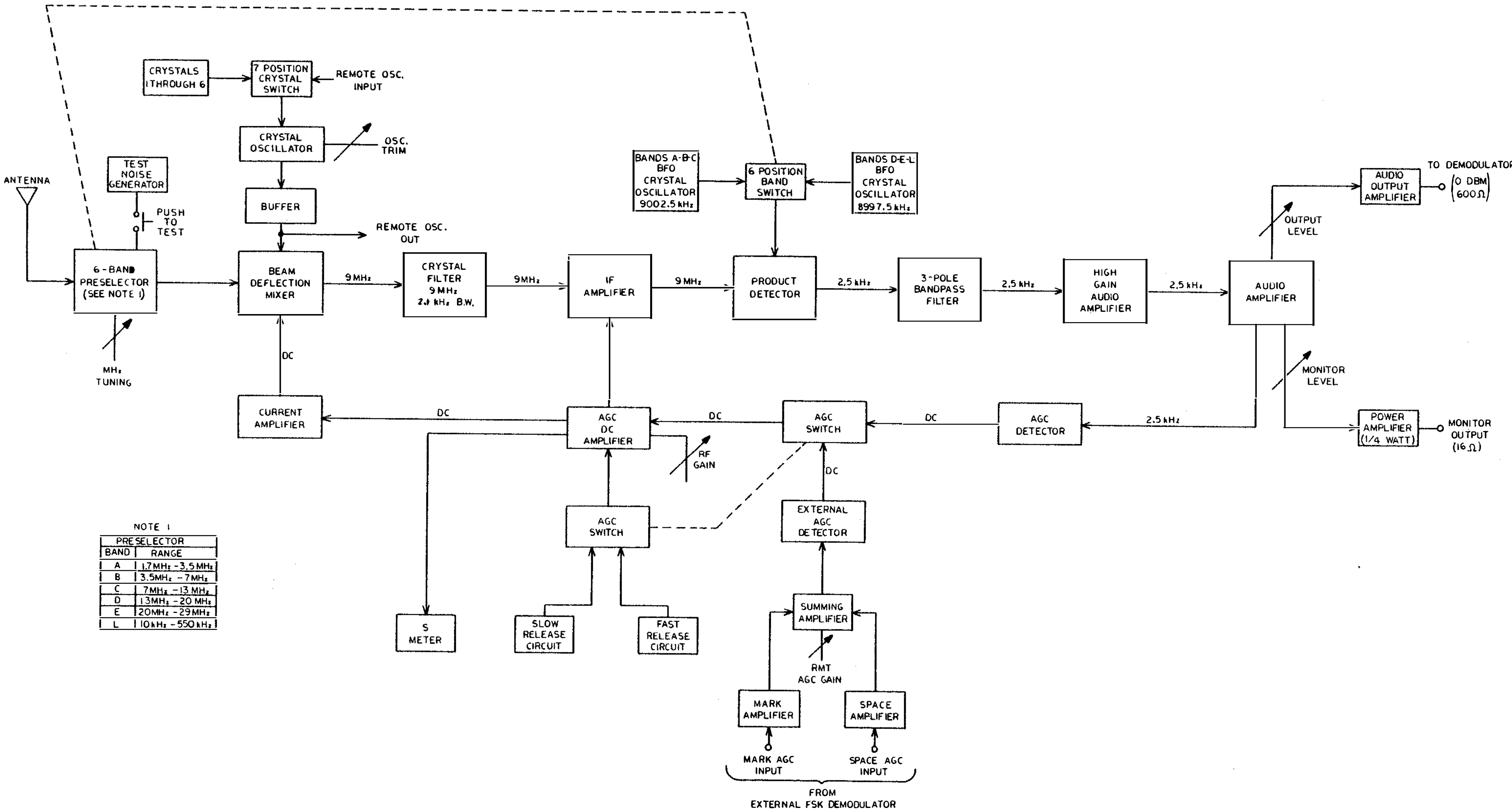


Figure 4-1. Functional Block Diagram

The audio output amplifier is a push-pull circuit with 600-ohm terminals for matching the input of an external demodulator. A front panel OUTPUT LEVEL control permits the audio signal to be varied up to a maximum of 10 dbm.

The monitor output amplifier is also a push-pull circuit with 16-ohm terminals for driving an external speaker or headphones. A front panel MONITOR LEVEL control permits the audio signal to be adjusted to a suitable listening level.

The AGC circuits, which include a detector, time constant circuits, and associated amplifiers, tend to hold the receiver output level constant despite changes in input signal strength. A front panel AGC switch permits selection of either an internally generated control voltage with slow or fast release times, or an externally generated signal voltage (with slow release time) from an associated demodulator. The internal AGC voltage is derived from the audio signal. In operation, this signal is successively detected, filtered, and amplified; afterwards, the resultant average dc component corresponding to changes in signal strength provides negative feedback to the cathode circuit of the beam deflection mixer stage and the emitter of the IF amplifier. If the signal received at the antenna begins to fade, the generated AGC voltage tends to increase the mixer and IF gain and thus maintain a constant output from the receiver. Similarly, increases in signal strength reduce the gain of both stages to produce the same effect.

The external signal used to derive the AGC control voltage is obtained from an FSK demodulator such as the Frederick Electronics Model 1200. Mating of the receiver and the Model 1200 produces an ideal environment for the detectors and patented Decision Threshold Computer (DTC) in the FSK demodulator. Operationwise, mark and space signals from the demodulator are separately amplified, and the resultant outputs are combined in a summing amplifier. An AGC detector then extracts the signal strength variations in the same manner as described for the internal AGC detector. The remaining operation is also identical to that of the internal AGC circuit.

The front panel AGC switch on the receiver has positions designated SLOW, FAST, and RMT. The first two positions are used with the internal AGC circuit and function as follows: SLOW AGC provides a fast attack and a slow release during the reception of FSK signals. This mode of operation introduces the proper amount of delay in release to suppress noise during momentary absences of the mark or space signal. FAST AGC provides both fast attack and fast recovery times. This mode of operation is advantageous during the reception of rapidly fading signals.

The RMT (remote) position of the AGC switch selects the external demodulator signal previously described. This mode of operation uses only the slow internal AGC time constant.

A front panel S-meter provides visual indication of both receiver tuning and relative signal strength. The S-meter is connected in the AGC dc amplifier circuit.

4.2 CIRCUIT DESCRIPTION

4.2.1 PRESELECTOR

Refer to figure 6-1. The preselector comprises six switch-selectable RF filters, a wave trap, and a noise generator. Five of these circuits, covering the 1.7 to 29 MHz range, each consists of a 4-pole high-Q toroidal filter and a tunable RF network; the remaining circuit, covering the 10 kHz to 550 kHz range, consists of a 4-pole high-Q toroidal filter with no tunable RF network. In operation, the preselector circuits accept RF signals at J19 from any unbalanced antenna having a transmission line impedance of 50 ohms. The signals are directed to the proper preselector circuit by means of BAND switch S1. For example, signals in the range of 1.7 to 3.5 MHz are directed to the band A preselector.

The tunable portion (1.7 to 29 MHz) of the preselector consists of the front panel MHz control (C1) and inductors L1 through L5. Each inductor is associated with a different preselector section. When a specific frequency range is selected by the BAND switch, the proper inductor is connected to C1. Manual adjustment of C1 will then peak the preselector to the desired frequency. C1 is switched out of the fixed-tuned portion (10 kHz to 550 kHz) of the preselector circuit.

The wave trap consists of a 9 MHz series-resonant crystal (Y1) located at the output of the preselector circuits. The wave trap provides a low impedance path to ground for signals at or near the 9 MHz IF of the receiver.

The noise generator consists of the base-emitter junction of Q1, and pushbutton switch S1. When S1 is depressed, the switch completes the dc path to ground through L3. The base-emitter junction is back-biased and breaks down in the reverse direction, generating large junction noises. The overall result is a wide even spectrum of white noise throughout the RF range. The reverse junction current is sufficiently limited by R4 to prevent permanent damage to the transistor.

4.2.2 MIXER STAGE

Refer to figure 6-2. The mixer stage consists of beam deflection tube circuit V1, and a 9 MHz crystal filter. V1 mixes the received signal with a local oscillator signal and provides a difference IF signal of 9 MHz. The beam deflection tube is unique in that its elements are so arranged that the cathode and control grid form an electron gun, and the deflecting electrodes form an electron lens. Together the gun and lens direct a beam of electrons towards the plates in a manner similar to that of the cathode-ray tube. Thus, the total tube current is varied by the input signal at the control grid and the division of tube current between the plates is varied by the local oscillator signal at the deflecting electrodes.

The input signal from the preselector is connected to the control grid (pin 3) of V1, and the input signal from the local oscillator is connected to one deflecting electrode (pin 8) of V1. Bypass capacitor C1 effectively grounds the other deflecting electrode (pin 9) to produce a single-ended input for the oscillator between ground and pin 8. In operation, the signal voltage variations on the control grid vary the total tube current, and the local oscillator signal variations at the deflecting electrode control the division of this current between the plates. The resultant mixing action within V1 produces sum and difference frequencies as well as the local oscillator frequency in the output circuit.

Absent from the mixer output is the original signal frequency appearing on the control grid. The suppression of this signal results from the fact that current is divided between the plates of V1 according to the voltage difference between deflecting electrodes. Since this is basically a push-pull action, the use of a balanced plate load circuit (L1) provides an approximate 35 db suppression of the control grid signal. A further reduction of the same signal is effected by means of balance potentiometer R2.

Of the three remaining signals in the mixer output, only the 9 MHz difference frequency is coupled to the IF stage. The other two signals are eliminated by means of a highly selective crystal filter circuit.

The crystal filter is a modularized 6-pole crystal lattice filter with a center frequency of 9 MHz and a bandpass of 2.1 kHz. The filter is driven from a winding on toroid L1. In operation, the 9 MHz mixer output is passed through the filter and connected to the base of the IF amplifier. Unwanted signals in the mixer output are rejected by the sharp skirt selectivity of the crystal-lattice filter.

4.2.3 LOCAL OSCILLATOR

Refer to figure 6-3. The local oscillator uses a single transistor (Q1) in a wideband oscillator circuit which provides a nominal 32 pf load for any one of six switch-selectable parallel resonant crystals. Individual crystal frequencies are chosen so that the difference between the received signal frequency and crystal frequency is always 9 MHz. On bands A, B. C, and L the crystal frequency must be 9 MHz above the received signal; on bands D and E the crystal frequency must be 9 MHz below the received signal. The oscillator output is buffered by emitter-follower stages Q2-Q3.

Individual crystal frequencies can be pulled slightly to compensate for small frequency discrepancies in the crystal by means of an associated trim capacitor (located above and adjacent to the crystal sockets). Operational adjustment of the local oscillator frequency in any crystal position is provided by means of a front panel OSC TRIM control C2. Adjustment of either trim control alters the value of the tuned circuit capacitance to a small degree, thereby varying the resonant frequency. The amount of frequency variation possible is proportional to the frequency of the crystal.

The CRYSTAL selector switch has an extra position (R) which selects the signal from an external oscillator via a rear panel connector. An optional frequency synthesizer, available from FEC, is specially designed to supply this signal input. The synthesizer eliminates crystal changing; frequencies are selected by merely dialing the desired frequency. In addition, the local oscillator output is routed to a rear panel oscillator output connector.

4.2.4 IF AMPLIFIER

Refer to figure 6-4. The IF amplifier consists of single transistor stage Q3. This is a low cross modulation stage that amplifies the 9 MHz output from the crystal-lattice filter. Transformer T1 couples the Q3 output to the product detector.

4.2.5 PRODUCT DETECTOR AND BEAT FREQUENCY OSCILLATORS

Refer to figure 6-4. The product detector, which comprises transistor stages Q4 through Q6, heterodynes the 9 MHz IF signal with a beat frequency oscillator (BFO) signal to develop a 2.5 kHz audio difference signal. The BFO signal is supplied by either one of two Pierce oscillator circuits (Q1 or Q2), as determined by the frequency band being received. The use of two beat frequency oscillators provides the proper relationship between local oscillator and BFO signals to insure that an increase in received signal frequency always results in an increase in detected signal frequency. This is in accordance with present communications standards.

Operationwise, the IF signal from T1 is connected to the Q4 section of the product detector. Q4 functions as a current source for the symmetrically connected Q5 and Q6 sections of the detector. BFO stage Q1 supplies a 9002.500 kHz signal to the base of Q5, and Q2 supplies an 8997.500 kHz signal to the base of Q6. The Q1 BFO is operative on bands A, B, C, and L; the Q2 BFO is operative on bands D and E.

When the Q1 BFO is used, its 9002.500 kHz signal input to Q5 produces the following action: Each positive alternation forward biases Q5, thereby increasing the Q4 current through Q5 and proportionately decreasing it through Q6. Each negative alternation reduces the Q4 current through Q5 and proportionately increases it through Q6. Similarly, when the Q2 BFO is used, its 8997.500 kHz signal input to Q6 allows the Q4 current to increase and decrease alternately through Q6 with proportional changes in Q5. In either case, the resultant switching action between Q5 and Q6 permits IF signal variations of the Q4 current to mix with the BFO signal and produce a 2.5 kHz difference signal at the detector output. The difference signal is coupled to a bandpass filter.

The audio bandpass filter is a 3-pole Butterworth filter with a center frequency of 2.5 kHz. The filter's sharp skirt selectivity yields an optimum bandpass around the FSK channel. Signals passing through the filter are amplified by high-gain, low-level audio amplifier Q7-Q8. Afterwards, the signals are coupled to amplifier stage Q1.

4.2.6 AUDIO AMPLIFIERS

Refer to figure 6-5. The audio amplifiers consist of a distribution amplifier, a monitor amplifier, and an output amplifier. Emitter-follower Q1 distributes the 2.5 kHz signal to the monitor and output amplifiers, and to the AGC circuit (via Q1's collector).

The audio monitor amplifier consists of driver stage Q11 and push-pull power amplifier stage Q12-Q13. This circuit provides a 2.5 kHz audio power output of approximately 1/4-watt into an external 16-ohm speaker. The audio monitor circuit also includes a MONITOR jack which accepts any standard impedance headphones. Insertion of the headphone plug into the MONITOR jack disconnects the speaker. The monitor output level is adjustable by means of MONITOR LEVEL control R6.

The audio output amplifier consists of driver stage Q8 and push-pull amplifier Q9-Q10. This circuit provides a 2.5 kHz audio output into 600-ohm terminals for matching the input of the external demodulator. OUTPUT LEVEL control R5 permits the audio signal level to be varied up to a maximum of 10 dbm.

4.2.7 AGC CIRCUITS

Refer to figure 6-5. The AGC circuits comprise internal detector Q2-Q3, dc amplifiers Q4-Q5, current driver Q6-Q7, remote mark-space amplifier Q17-Q18, summing amplifier Q14, and remote detector Q15-Q16. These circuits function to maintain a constant output from the receiver despite variations in the input signal. In operation, the AGC control voltages are developed from either the internal audio or from a remote input signal. The remote input signal consists of the mark and space audio from an external demodulator.

The 2.5 kHz audio signal at the collector of Q9 is coupled through T1 and to the bases of active detector Q2 and Q3. The resultant rectified negative-going detector pulses are selected by either the SLOW or FAST position of AGC switch S3 and routed to the base of Q4. If RF GAIN control R4 is set at minimum gain (maximum negative), negative voltage is coupled through CR1 to increase current flow in Q4. This action tends to reduce the current in Q5, causing a corresponding increase in the Q6 current and a decrease in the Q7 current. The overall effect of the operation is to reduce receiver gain by feeding back a positive voltage to both the cathode of mixer stage V1 and the emitter of IF stage Q3.

During normal signal reception the RF GAIN control is rotated to some higher gain position (slider moves towards ground). As a result, less negative voltage is coupled through CR1 and the detected audio signal assumes control of the circuit. Current in Q4 through Q7 will thus vary in accordance with the detected signal, causing more or less current to flow through V1 and Q3. Strong signals increase the negative feedback to the mixer and IF amplifiers, thereby reducing receiver gain; weak signals decrease the feedback to produce the opposite effect.

The slow and fast positions of the AGC switch permit the operator to choose the most favorable operating conditions for a given receiving condition. Slow AGC is normally desirable for receiving FSK signals, since a slow release time introduces the proper amount of delay to suppress noise during momentary signal fadeouts. The slow release circuit in the Receiver consists of capacitor C8 and resistors R14-R15. Release time is approximately 7.5 seconds.

Fast AGC is desirable for receiving FSK signals during rapid fades, since receiver sensitivity recovers quickly enough to follow the changing signal. The fast release circuit consists of capacitor C7 and resistors R14-R15. Release time is approximately 1.1 seconds.

The external signal input to the AGC circuit consists of mark and space tones from an external FSK demodulator such as the FEC Model 1200. The mark tone is connected across pins 8 and 6 of rear panel Molex connector J21; the space tone is connected across pins 7 and 6 of the same connector. These tones are coupled through their respective transformers (T2 and T3) and connected to separate amplifiers: Q17 for the mark and Q18 for the space. The tone outputs are summed by amplifier Q14 and the resultant collector signal is coupled through T4 to active detector Q15-Q16. The detected output is then routed through the remote position of the AGC switch and applied to the base of Q4. From this point on, circuit operation is identical to that for the internal AGC.

External AGC is controlled by potentiometer R3. Adjustment of R3 varies the amount of degenerative feedback applied to Q14. Maximum gain is obtained with the slider of R3 at ground; minimum gain is obtained with the slider at the other extreme.

4.2.8 POWER SUPPLY

Refer to figure 6-6. The power supply consists of a +12 vdc full-wave rectifier, a -12 vdc full-wave rectifier, a +18 vdc full-wave rectifier, a +150 vdc full-wave bridge rectifier, and a 6.8 volt filament transformer. The rectifier circuits furnish all dc operating voltages for the transistors and the vacuum tube in the receiver. The 6.8 volt filament transformer provides ac filament voltage for the vacuum tube.

SECTION VI

SCHEMATIC DIAGRAMS

FIGURE

Chart I. Alignment Data, Model 1500 (cont.)

Step	Generator Connections	Generator Frequency	Counter Connections	Voltmeter Connections	Band Switch	AGC Switch	Procedure
B. IF ALIGNMENT (cont.)							
							*Receiver output should not exceed 10 dbm during these adjustments. Reduce generator level to meet this condition. Remove voltmeter leads. Restore receiver to initial conditions.
C. MIXER BALANCE							
1	Connect to J19 on rear panel. (Common lead to chassis and input lead to center pin of J19.)	9000.000 kHz Adjust generator as described above in step 1 of B, then insert signal into J19.			C	RMT	Remove 9.000 MHz crystal from board N0730. Adjust generator for an injection level of approximately 100 microvolts. (+40 db above 1 microvolt.) Adjust MIX-BAL potentiometer (rear panel) for minimum S-Meter reading and/or minimum audio output. Remove generator, replace 9.000 MHz crystal, and restore receiver to normal service.

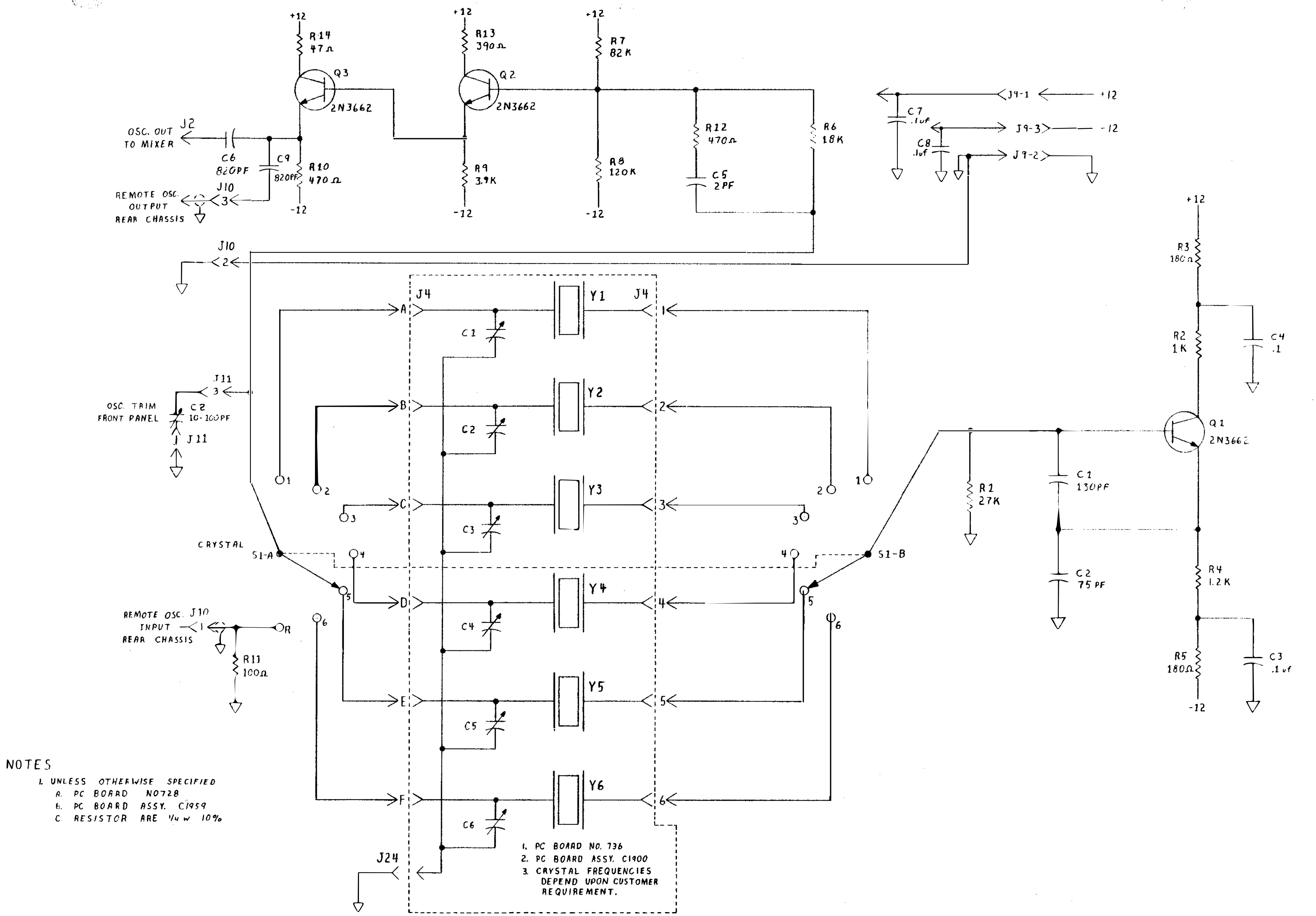
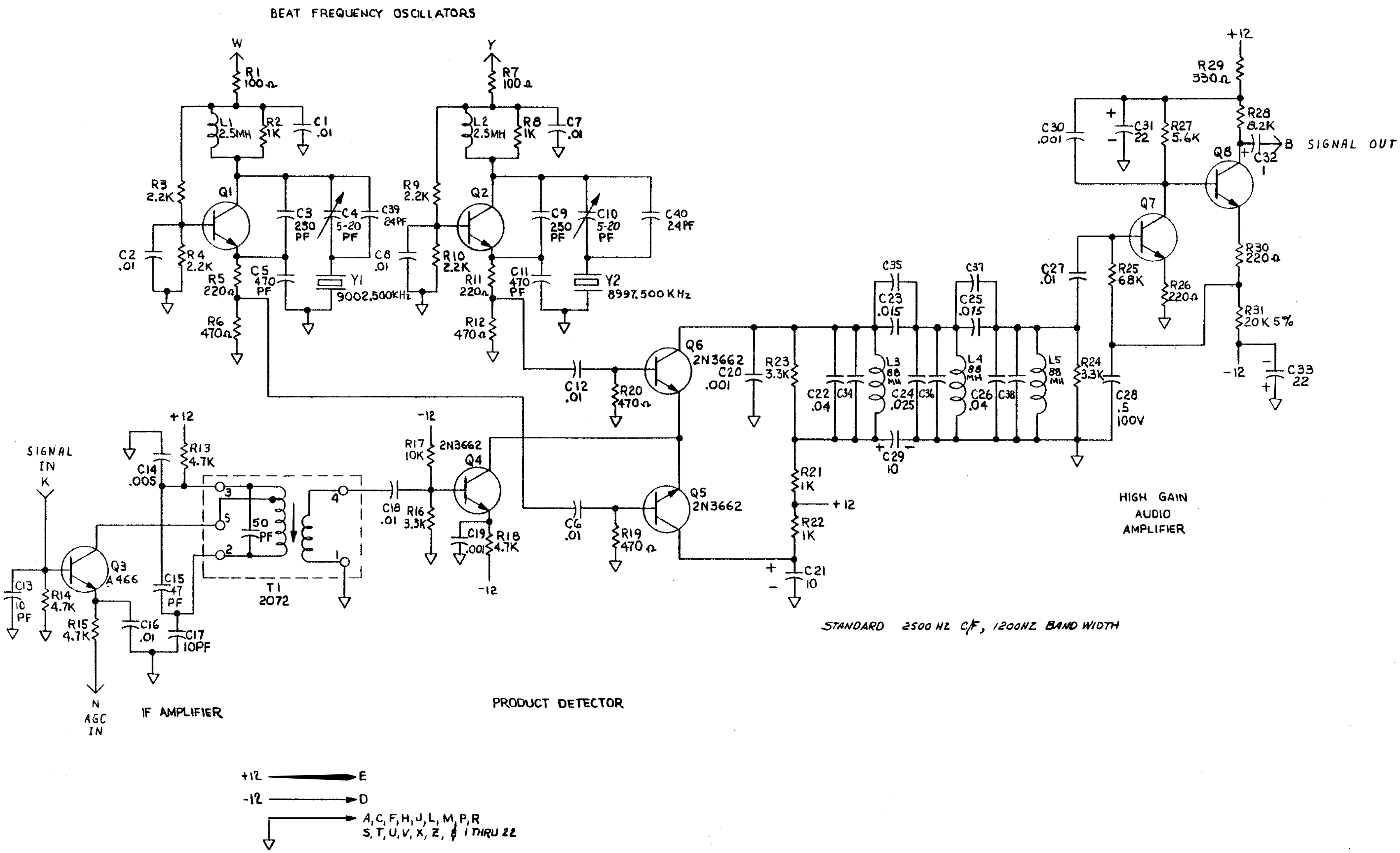


Figure 6-3. Local Oscillator, Schematic Diagram
N0728-J9 thru J11 & J24-D1674A



NOTES:
1. UNLESS OTHERWISE SPECIFIED
TRANSISTORS ARE 2N3903
RESISTORS ARE 1/4W ±10%
CAPACITORS ARE IN MFD.
2. P.C. BOARD ASSY. D1669
3. P.C. BOARD N0726

TABLE I

JOB NO.	COMPONENTS BELOW ARE TO BE SUBSTITUTED FOR JOB SHOWN, USE SAME TYPE & TOL. EXCEPT NOTED														
	C22	C23	C24	C25	C26	C27	C28	C34	C35	C36	C37	C38	Y1	Y2	CTR. HZ	BD. WIDTH
2066 ONLY	.04	.0068	.0068	.0068	.04	.01	10μF	.033	.0068	.05	.0068	.033	9001.9KHz	8998.1KHz	1900 HZ	400 HZ

Figure 6-4. IF, BFO, and Detector, Schematic Diagram
N0726-J2-D1668B

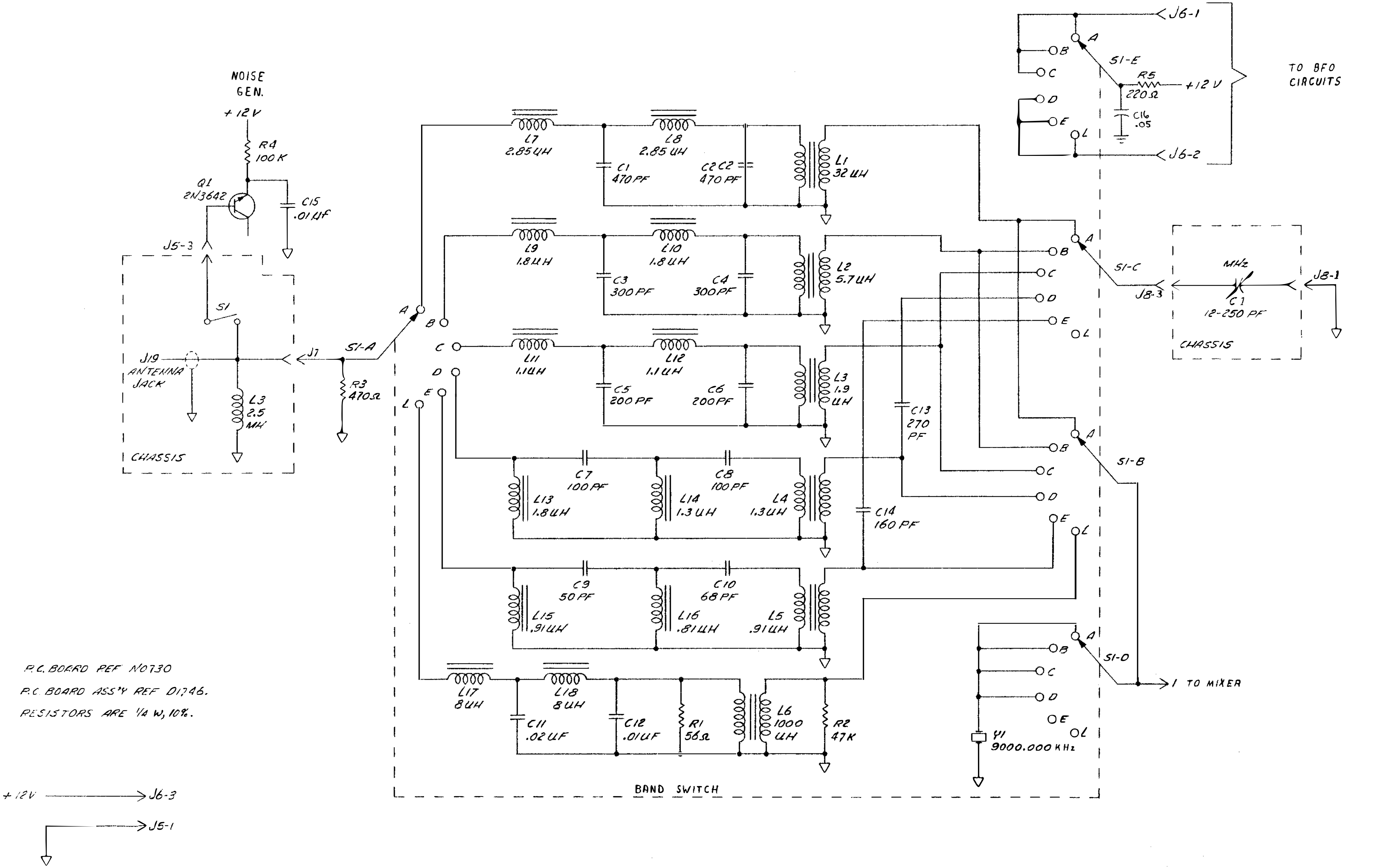


Figure 6-1. Preselector, Schematic Diagram
N0730-J5 thru J8-D1745B

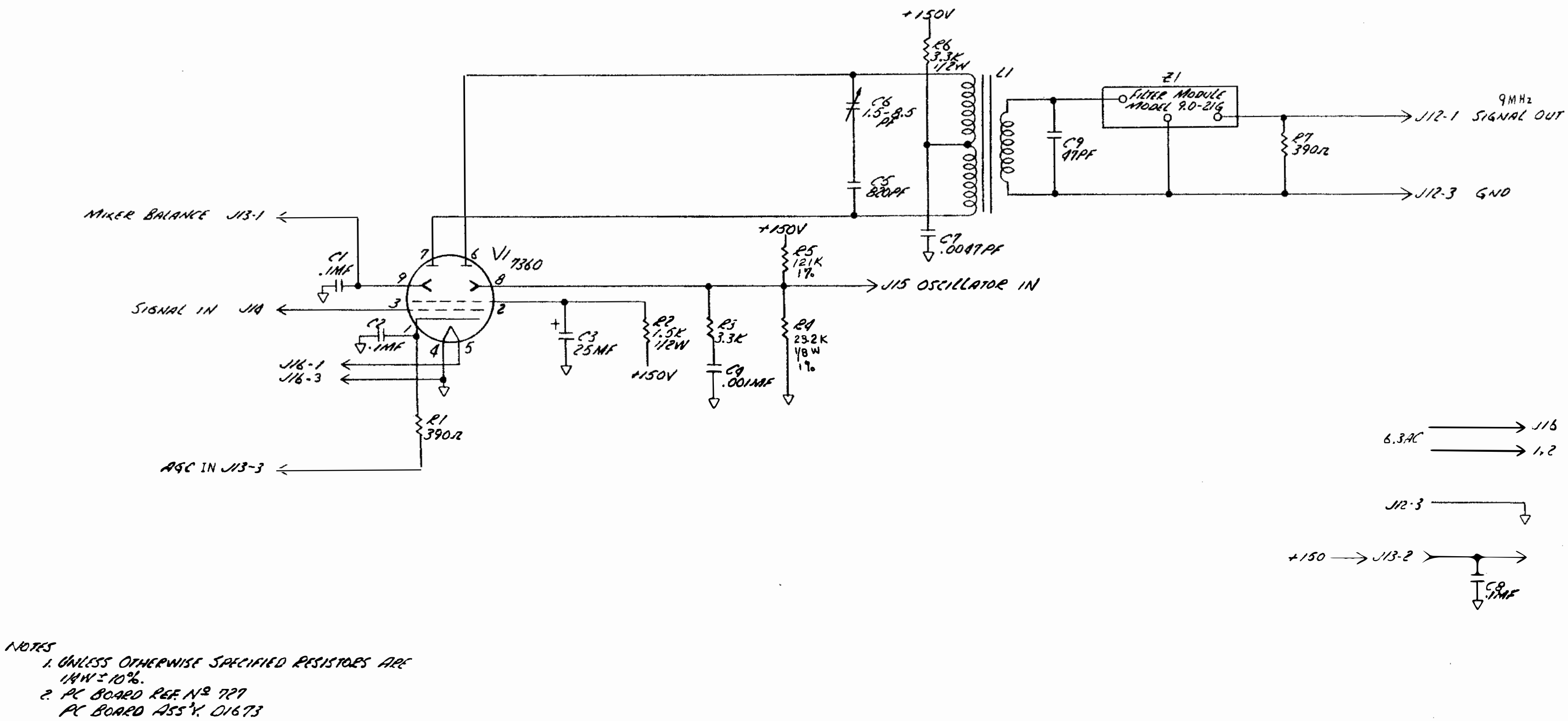


Figure 6-2. Mixer, Schematic Diagram
N0727-J12 thru J16-D1672D

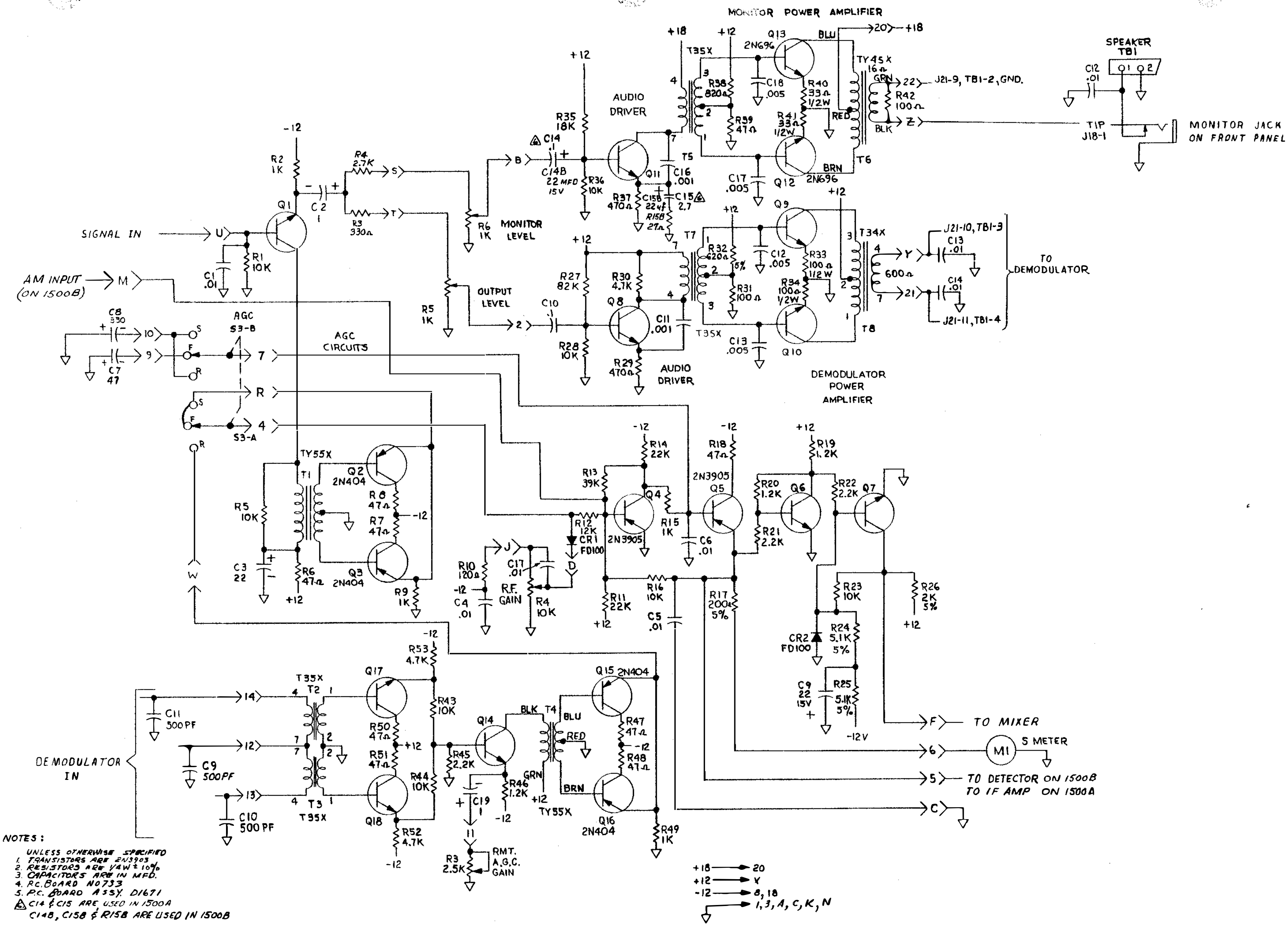
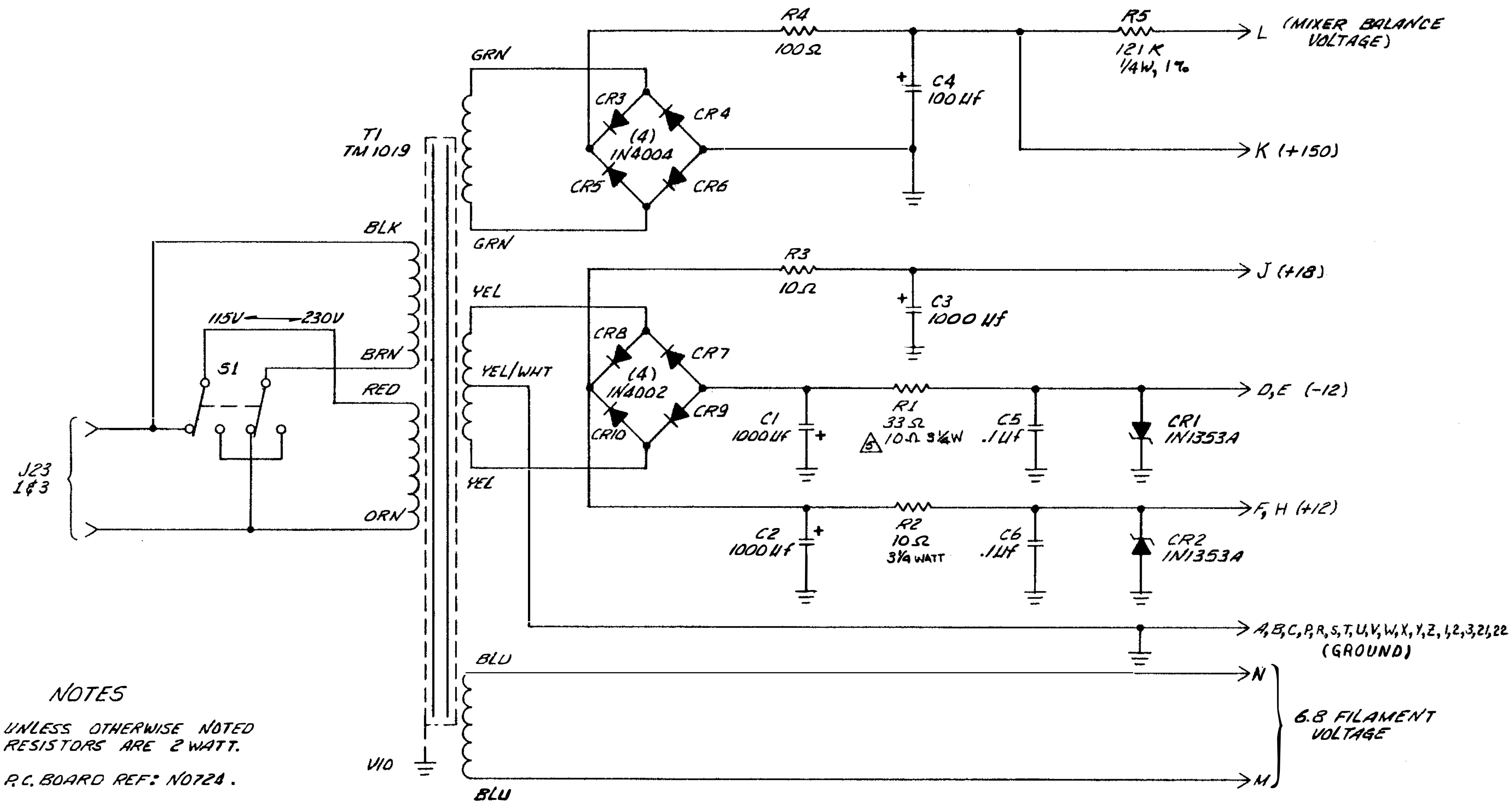


Figure 6-5. Audio and AGC, Schematic Diagram
N0733-J3-D1670C



NOTES

1. UNLESS OTHERWISE NOTED RESISTORS ARE 2 WATT.
2. P.C. BOARD REF: N0724.
3. P.C. BOARD ASS'Y REF: D1676.
4. FOR 115V OPERATION, CONNECT RED & BRN LEADS IN PARALLEL. FOR 230V OPERATION, CONNECT RED & BRN LEADS IN SERIES.

(5) USE FOR 1500B ONLY

Figure 6-6. Power Supply, Schematic Diagram
N0724-J1-C1899D

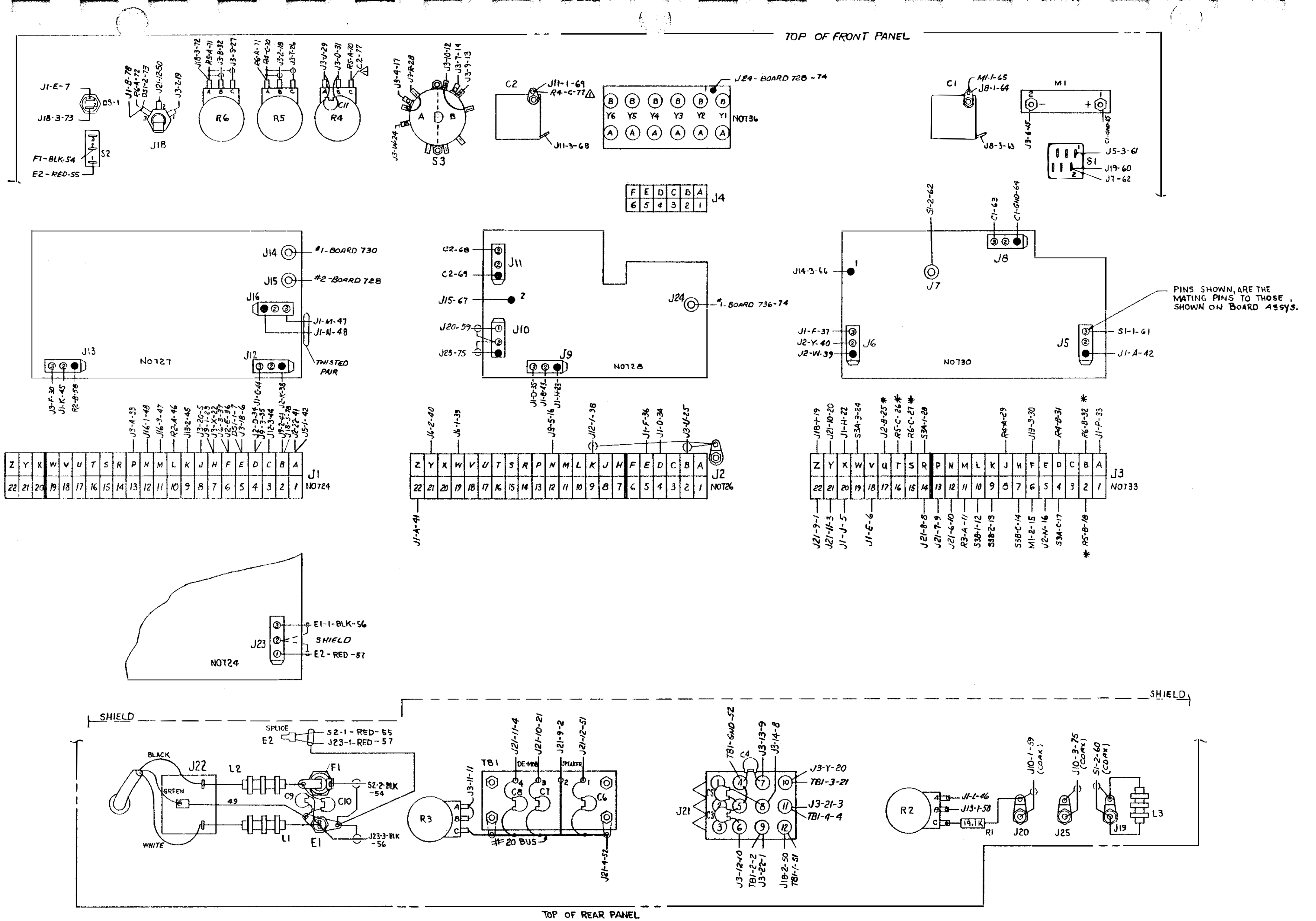
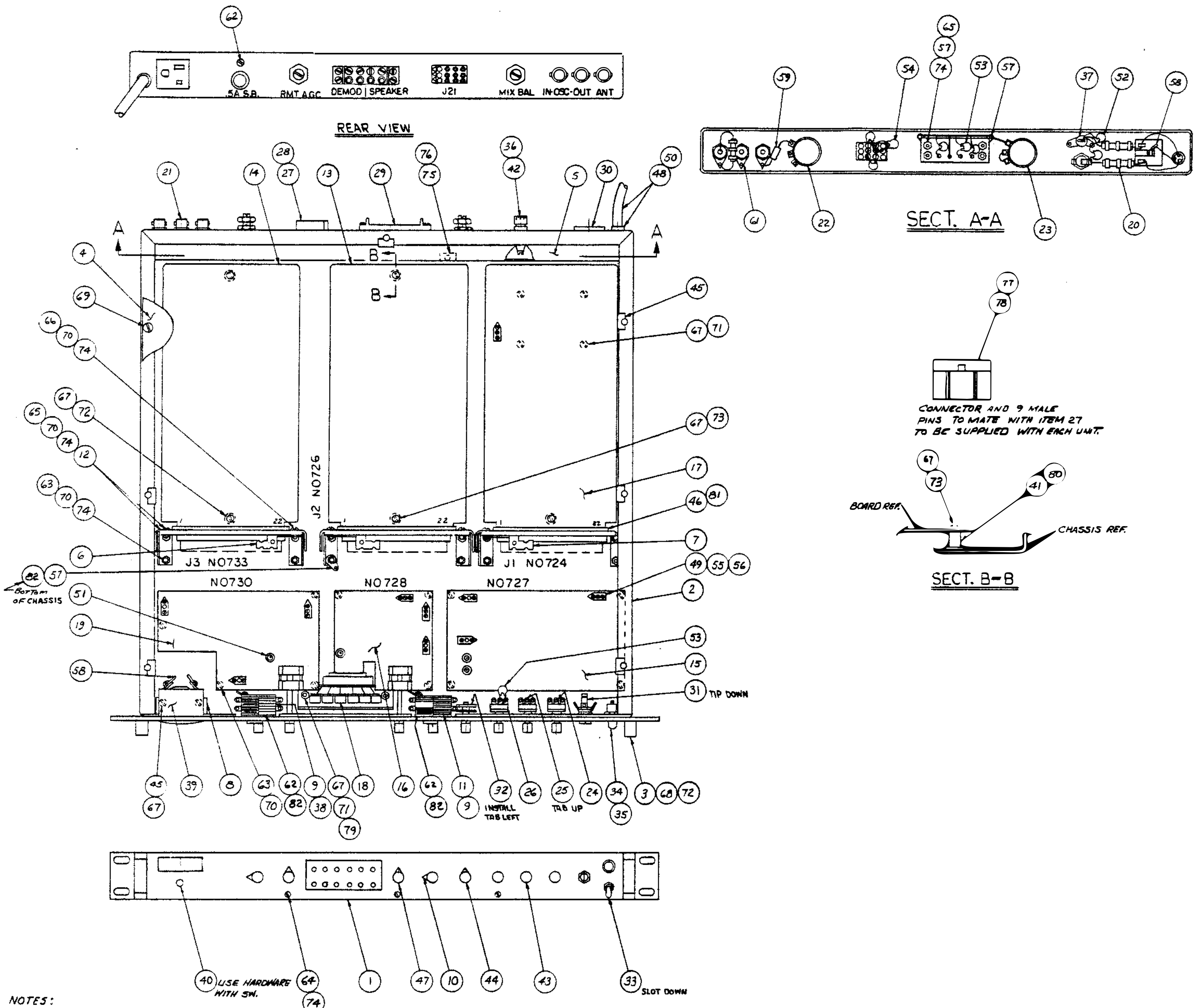


Figure 6-7. Wiring Diagram D1750B

SECTION VII

ASSEMBLY DRAWINGS

FIGURE



NOTES:
1. WIRING DIAGRAM D1750 REF.
2. STENCIL AS SHOWN.
3. PLASTIC SLEEVING AS REQUIRED.
4. CRYSTALS ARE OPTIONAL.

Figure 7-1. Model 1500A, Assembly D1667C

ITEM	REQ'D	PART NO	DESCRIPTION	MAT'L OR MFR	MAT'L SPEC OR CAT. PART NO.	FINISH
82	5		WASHER, #4 EXTERNAL TOOTH		PHOS. BRZ.	
81	3	67611-6	KEY, CONNECTOR	AMP		
80	5		WASHER, #10 INT. TOOTH		PHOS. BRZ.	
79	2		NUT, HEX 6-32 x 1/4 AF		SST	
78	9	1380TL	TERMINAL, MALE	MOLEX		
77	1	1360P	CONNECTOR, MALE	MOLEX		
76	3		SCREW, #4 SHEET METAL		SST	
75	3	C15263-42-24	SPEED NUT #4	TINNERMAN		
74	25		NUT, HEX. 4-40 x 1/4 AF		SST	
73	3		WASHER, #6 EXT. TOOTH		PHOS. BRZ.	
72	6		WASHER, #6 SPLIT LOCK			
71	6		WASHER, #6 INT. TOOTH			
70	38		WASHER, #4 INT. TOOTH		PHOS. BRZ.	
69	7		SCREW, 6-32x5/16 FLAT HD.	UNDER-CUT	SST	
68	4		6-32x3/8 FIL. HD.			
67	9		6-32x1/4 RD. HD.			
66	3		4-40x5/8 RD. HD			
65	7		4-40x1/2 RD. HD.			
64	3		4-40 x 3/8 OVAL HD.			
63	23		SCREW, 4-40 x 5/16 RD. HD.			
62	5		SCREW, 4-40 x 1/4 RD. HD.		SST	
61	3	1497	SOLDER LUG x	SMITH		
60	A/R	SST1	TIE OFF	PANDUIT		
59	1	RN55D1912F	RESISTOR, 19.1K 1/8 WATT 1%	A-B		
58	3	1416-6	SOLDER LUG	SMITH		
57	5	1416-4	SOLDER LUG.	SMITH		
56	20	1561-TLB	PIN, FEMALE	MOLEX		
55	9	1560-TLB	PIN, MALE	MOLEX		
54	3	DD-501	CAPACITOR, 500 PF 1KV	CRL		
53	4	5835-Y5U-1032	CAPACITOR, .01 μf 25V	ERIE		
52	2	5HK-S10	CAPACITOR, .01 μf 1000V	SPRAGUE		
51	4	1625-1R	CONNECTOR, SINGLE PIN	MOLEX		
50	1	SP-1	STRAIN RELIEF	HEYCO		
49	10	1625-3R1	CONNECTOR, 3 PIN	MOLEX		
48	1	17237	LINE CORD	BELDEN		
47	2	50-1-1G	KNOB, ROUND	RAYTHEON		
46	3	67031-7	CONNECTOR	AMP		
45	10	C8020-632-67	SPEED NUT #6	TINNERMAN		
44	3	50-5-1G	KNOB, POINTER	RAYTHEON		
43	5	50-2-1G	KNOB, ROUND	RAYTHEON		
42	1	3AG 1/2 A	FUSE 1/2 AMP SLO-BLOW	LITTELFUSE		
41	5	1246-20	STANDOFF	CTC		
40	1	976	SWITCH, DPDT	SWITCHCRAFT		
39	1	MODEL 13	METER 0-5 Ma.	EMICO	082-000-242 HALLICRAFTERS	
38	1	60-4635-9	VARIABLE CAP. 12-280 PF	STAR PROD.		
37	1	750	STANDOFF	WINCHESTER		
36	1	342004	FUSE SOCKET	LITTELFUSE		
35	1	327	LAMP	G.E.		
34	1	162-8430-931-	PILOT LIGHT ASSY.	DIALCO		
33	1	MST-115D	SWITCH, SPDT	ALCO		
32	1	X72031N	ROTARY SWITCH	JBT		
31	1	12A	PHONE JACK	SWITCHCRAFT		
30	1	M1536-GS	A.C. RECEPTACLE	CIRCLE F		
29	1	4-140-Y	BARRIER STRIP	C-J		
28	9	1381TL	PIN, FEMALE	MOLEX		
27	1	1360R	CONNECTOR	MOLEX		
26	1	RS 9850	POT. 10K	CTS		
25	1	PB 3205A	POT. 1K	CTS		
24	1	RS 9849	POT. 1K	CTS		
23	1	CLU-2521	POT. 2.5K	OHMITE		
22	1	CLU-1031	POT. 10K	OHMITE		
21	3	95-712-667-6	CONNECTOR, BNC	DAGE		
20	3	6302	CHOKE 2.5 mh	MILLER		
19	1	D1746	ASSY. PRESELECTOR	FEC	NO 730A	
18	1	C1900	ASSY. CRYSTAL & TRIM CAP.		NO 736	
17	1	D1676	ASSY. POWER SUPPLY		NO 724	19 & 20
16	1	C1959	ASSY. OSCILLATOR		NO 728A	
15	1	D1673	ASSY. MIXER		NO 727A	
14	1	D1671	ASSY. AUDIO & AGC.		NO 733	13 & 14
13	1	D1669	ASSY. BFO. IF AMP. AUDIO FILTER		NO 726A	6 & 7
12	3	C1303-4	PLUG HOLDER ASSY.	FEC		
11	1	5632	OSCILLATOR TRIM CAPACITOR	STAR PROD.		
10	2	B1074	POINTER, CAPACITOR	FEC		
9	2	B1086	SHIM, CAPACITOR			
8	1	B1454	BRACKET, METER MTG.			
7	2	B1124-2	CABLE CLAMP			
6	1	B1124-1	CABLE CLAMP			
5	1	C1645	SHIELD, POWER			
4	1	C0706	COVER			
3	2	B1132	BAR, FRONT PANEL			
2	1	C1896	CHASSIS			
1	1	C1897	FRONT PANEL ENGRAVED	FEC		

Figure 7-1. Parts List

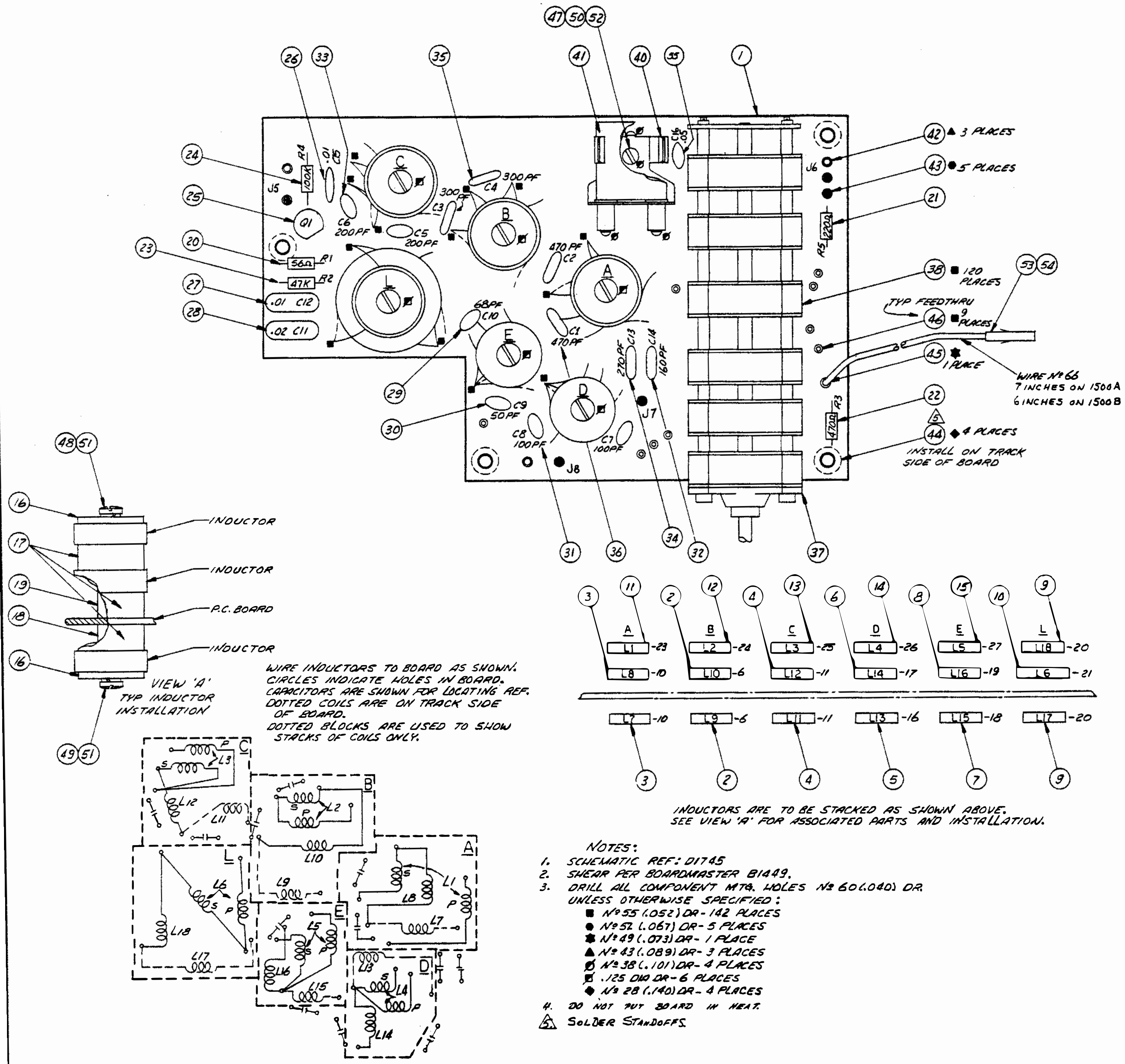


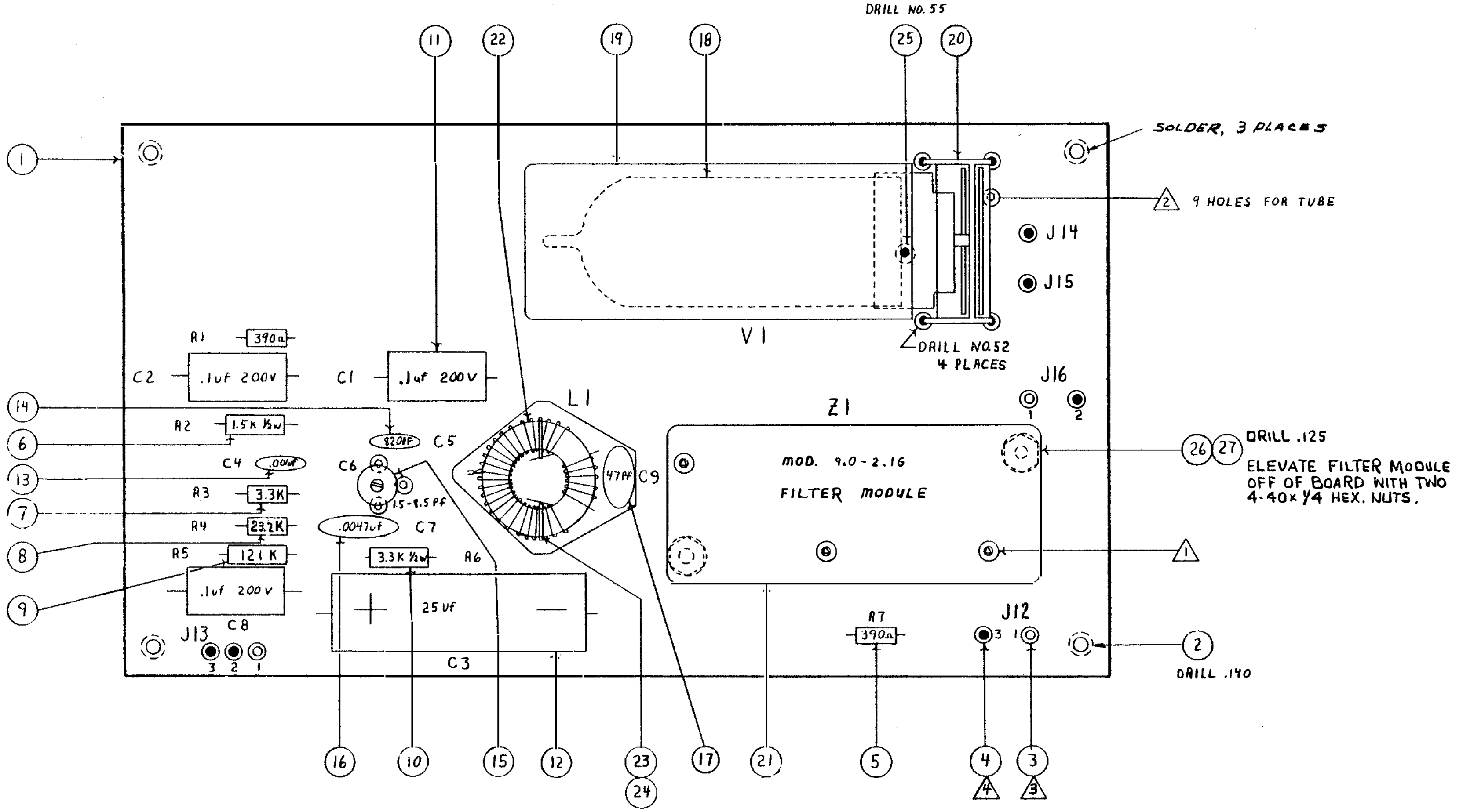
Figure 7-2. Preselector, Board Assembly
N0730-J5 thru J8-D1746B

ITEM	REQ'D	PART NO	DESCRIPTION	MAT'L OR MFR	MAT'L SPEC OR CAT. PART NO.	FINISH	FINISH SPEC	CKT SYM
27	2		WASHER, NO. 4 SPLIT LOCK	SS				
26	4		NUT, HEX 4-40	SS				
25	1	S6064	EYELET	VS				
24	AIR		TUBING 22 GA. NATURAL	ALPHA				
23	AIR		22 GA. SOLID WIRE	ALPHA				
22	1	C1322-2	COIL ASSEMBLY	FEC				
21	1	MOD. 9.0-2.1G	FILTER MODULE	CF NETWORK				
20	1	05-4009	TUBE SOCKET, P.C. MOUNT	ELCO				
19	1	TRT6-6025	TUBE SHEILD	IERC				
18	1	7360	TUBE	RCA				
17	1	OM 15 470J	CAPACITOR 47 UF 500V	ELMENCO				
16	1	56A047	" .0047 UF 1KV	SPRAGUE				
15	1	HT10KA129	" 1.5-9.5 PF	AMPEREX				
14	1	JF82025F	" 820 PF 1KV	SPRAGUE				
13	1	801 X5F 102K	" .001 UF 1KV	ERIE				
12	1	39D256F150EJ4	" 25 UF 150 VDC	SPRAGUE				
11	3	192P10492	CAPACITOR .1UF 200V 192P	SPRAGUE				
10	1		RESISTOR 3.3K 1/2 WATT 10%	A.B.				
9	1	RN60D1213F	" 121K, 1/4 WATT 1%	"				
8	1	RN55D2322F	" 23.2K, 1/8 WATT 1%	"				
7	1		" 3.3K 1/4 " 10%	"				
6	1		" 1.5K 1/2 " 10%	"				
5	2		RESISTOR 390Ω 1/4 WATT 10%	A.B.				
4	6	R62-3-ET	MALE STAKE PIN	BEAD CHAIN				
3	3	M93-102-ET	FEMALE STAKE PIN	BEAD CHAIN				
2	4	1300-11	1/4" STANDOFF	CTC				
1	1	N0727A	PC BOARD	FEC				

Figure 7-3. Parts List

ITEM	REQ'D	PART NO	DESCRIPTION	MAT'L OR MFR	MAT'L SPEC OR CAT PART NO	FINISH	FINISH SPEC	CKT SYM
55	1	5855Y5U503Z	CAPACITOR, .05 MFD. 25V	ERIE				
54	1	1561TL8	TERMINAL, FEMALE	MOLEX				
53	6"		WIRE №20 GA STRANDED	ALPHA	WHITE			
52	1		NUT, №2-56 x 3/16 AF	SST				
51	12		WASHER, №4 SPLIT LOCK					
50	1		WASHER, №2 SPLIT LOCK					
49	6		SCREW, №4-40 x 3/4 Bd Hd					
48	6		SCREW, №4-40 x 1/4 Bd Hd					
47	1		SCREW, №2-56 x 3/16 Bd Hd	SST				
46	9	5-6065	EYELET	U.S.				
45	1	2059	EYELET	STIMPSON				
44	4	1300-13	STANDOFF	CTC				
43	5	R62-3-ET	STAKE PIN - MALE	BEAD CHAIN				
42	3	M93-102-ET	STAKE PIN - FEMALE	BEAD CHAIN				
41	1	MIL TYPE CR19U	CRYSTAL 9 MHz SERIES RES	ERIE				
40	1	8000-A-G3	CRYSTAL SOCKET	AUGAT				
39								
38	5	606110	SECTION, NON-SHORTING 12 POS 1 POLE	ITT	TYPE JSR 325			
37	1	601065	SHAFT & DETENT ASS'Y, 6 POS	ITT	O/S SHAFT: 1.25 I/S SHAFT: 3.25			
36	2	DM15-471J	CAPACITOR 470 PF, 500V, 5%	ARCO				
35	2	DM15-301J	300 PF					
34	1	DM15-271J	270 PF					
33	2	DM15-201J	200 PF					
32	1	DM15-161J	160 PF					
31	2	DM15-101J	100 PF					
30	1	DM15-500J	50 PF					
29	1	DM15-680J	68 PF, 500V, 5%					
28	1	1MD-1-203J	.02 UF, 100V, 5%					
27	1	1MD-1-103J	.01 UF, 100V, 5%	ARCO				
26	1	5835-Y5U-103Z	CAPACITOR .01 UF, 25V	ERIE				
25	1	2N3642	TRANSISTOR	FAIRCHILD				
24	1		RESISTOR 100K, 1/4 W, 10%	AB				
23	1		47K					
22	1		470Ω					
21	1		220Ω					
20	1		RESISTOR 56Ω, 1/4 W, 10%	AB				
19	6	81090-2	NYLON ROD, THREADED	F.E.C.				
18	6	81452-1	NYLON ROD					
17	18	81098	SPACER					
16	12	81453	WASHER					
15	1	C1146-27	TOROID INDUCTOR					
14	1	-26						
13	1	-25						
12	1	-24						
11	1	-23						
10	1	-21						
9	2	-20						
8	1	-19						
7	1	-18						
6	1	-17						
5	1	-16						
4	2	-11						
3	2	-10						
2	2	C1146-6	TOROID INDUCTOR					
1	1	N0730B	P.C. BOARD	F.E.C.				

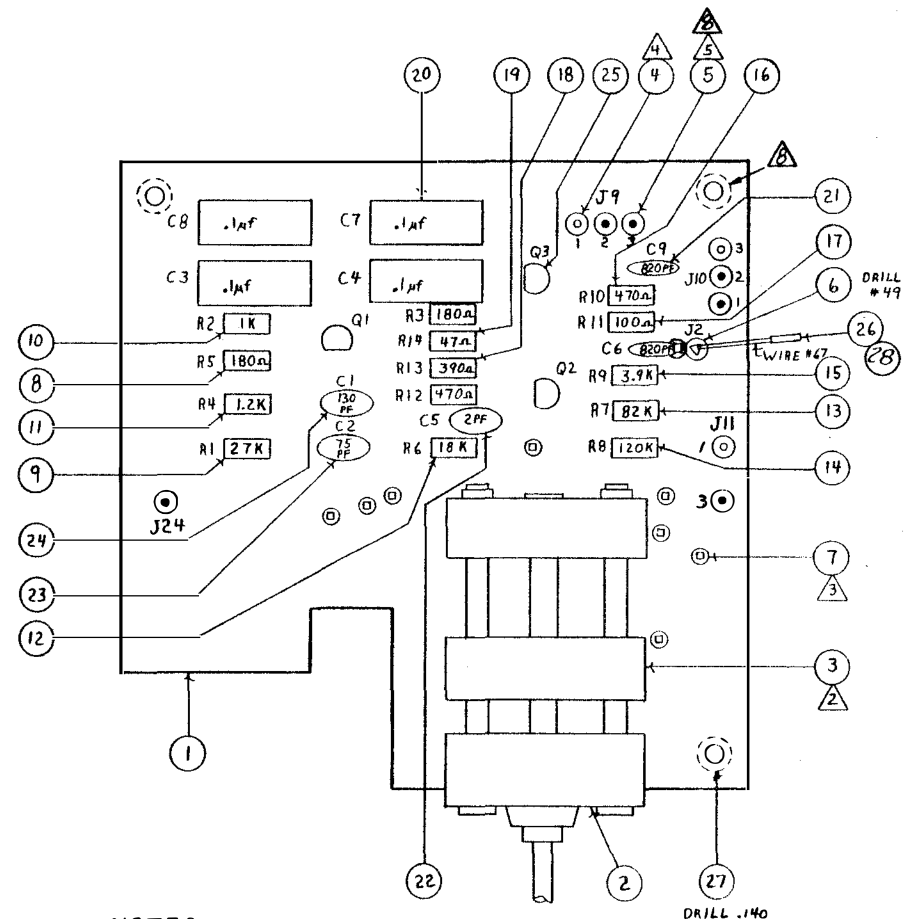
Figure 7-2. Parts List



NOTES:

1. DRILL NO. 49
2. DRILL NO. 55
3. DRILL NO. 43
4. DRILL NO. 52
5. DRILL NO. 60 HOLES UNLESS OTHERWISE SPECIFIED
6. SCH. REF. D1672

Figure 7-3. Mixer, Board Assembly
N0727-J12 thru J16-D1673G

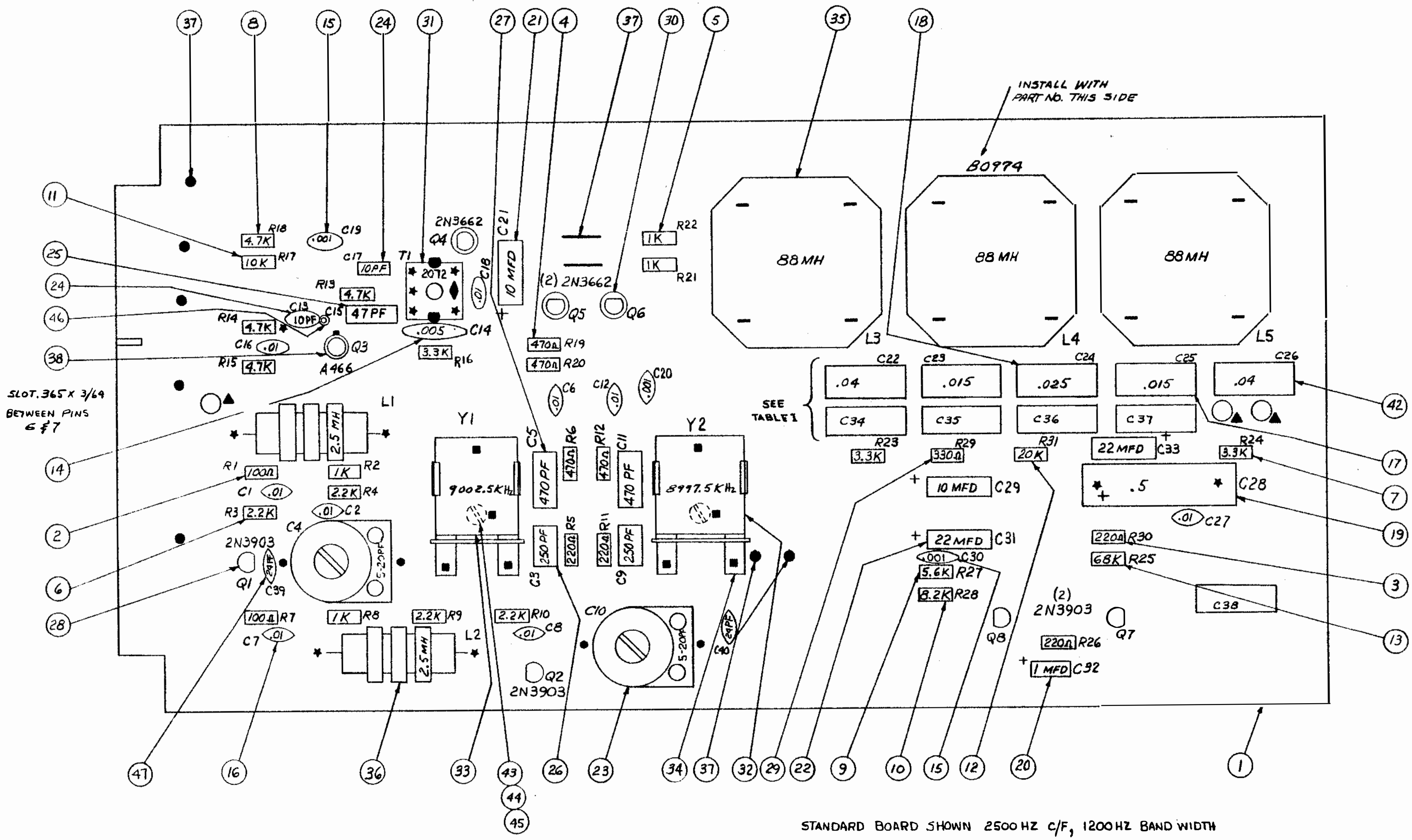


NOTES.

1. DRILL NO. 60 HOLE UNLESS OTHERWISE SPECIFIED.
2. DRILL ALL SWITCH HOLES NO. 55
3. ◎ DRILL NO. 55
4. ◎ DRILL NO. 43
5. ⦿ DRILL NO. 52
6. SCH. REF. D1674
7. DO NOT PUT BOARD IN HEAT.
8. SOLDER MALE PINS & STANDOFF

ITEM	REQ'D	PART NO	DESCRIPTION	MAT'L OR MFR	MAT'L SPEC OR CAT. PART NO.	FINISH	FINISH SPEC	CKT SYM
28	A/R		WIRE 20GA STRANDED	ALPHA				
27	3	1300-13	1/2" STANDOFF	CTC				
26	1	1381TL	FEMALE PIN	MOLEX				
25	3	2N3662	TRANSISTOR	G.E.				
24	1	DM10-131J	CAPACITOR, 130 PF ± 5%	ARCO. ELM.				
23	1	DM10-750J	75 PF ± 5%					
22	1	DM15-020D	2 PF ± .5PF	ARCO. ELM.				
21	2	JF820Z5F	820 PF	AMC				
20	4	192P10492	CAPACITOR, .1uf 200 volt	SPRAGUE				
19	1		RESISTOR, 47Ω 1/4 watt 10%	A B				
18	1		390Ω					
17	1		100Ω					
16	2		470Ω					
15	1		3.9 K					
14	1		120 K					
13	1		82 K					
12	1		18 K					
11	1		1.2 K					
10	1		1K					
9	1		27K					
8	2		RESISTOR, 180Ω 1/4 watt 10%	A B				
7	9	56064	EYELET	USMC				
6	1	2059	EYE LET	STIMPSON				
5	6	R62-3-ET	MALE STAKE PIN	BEAD CHAIN				
4	3	M43-102-ET	FEMALE STAKE PIN	BEAD CHAIN				
3	2	JSR-325-1010	SECTION NO SHORTING 12 POS. 1PD	ITT				
2	1	JSR-325-30-7EMMH	SHAFT & DETENT ASSY 7POS. 1.25 O.S 1.81 I.S	ITT				
1	1	NO728B	P.C. BOARD	FEC				

Figure 7-4. Local Oscillator, Board Assembly
N0728-J9 thru J11 & J24-C1959B



NOTES:

1. SCHEMATIC REF. D1668
2. UNLESS OTHERWISE SPECIFIED DRILL ALL HOLES NO. 60 DR(.040)

▲ 5/32 DR. (.156) 3 PLACES

✱ 55 DR. (.052) 12 PLACES — DR. #51 (.067) 12 PLACES

■ 38 DR. (.101) 8 PLACES

● 49 DR. (.073) 2 PLACES

♦ 1/8 DR. (.125) 1 PLACE

● 34 DR. (.111) 4 PLACES

4. ITEMS 32 & 33 ARE 32 PF LOAD. TOL. ±.0005% @ 26° C., TEMP. TOL. ±.003% FROM -30° C. TO 60° C.
5. DO NOT USE SOLVENT TO CLEAN BOARD.

TABLE I

JOB NO.	COMPONENTS BELOW ARE TO BE SUBSTITUTED FOR JOB SHOWN, USE SAME TYPE & TOL. EXCEPT NOTED														
	C22	C23	C24	C25	C26	C27	C28	C34	C35	C36	C37	C38	Y1	Y2	CTR. FREQ.	Bd. WIDTH
2066 ONLY	.04	.0068	.0068	.0068	.04	.01	10 μF	.033	.0068	.05	.0068	.033	9001.9KHz	8998.1KHz	1900 HZ	400 HZ

2200

Figure 7-5. IF, BFO, and Detector, Board Assembly
N0726-J2-D1669B

ITEM	REQ'D	PART NO	DESCRIPTION	MAT'L OR MFR	MAT'L SPEC OR CAT. PART NO.	FINISH	FINISH SPEC	CKT SYM
△5 48	2	V500-226X901582	CAPACITOR, 22 MFD 15V	SPRAGUE				
△5 47	1		RESISTOR, 27Ω 1/4W ± 10%	A-B				
46	1	V500275X9015A2	CAPACITOR 2.7 UF 15V	SPRAGUE				
45	16		NUT, HEX 2-56 3/16 AF	BRASS		NI-P		
44	1		RESISTOR, 39K 1/4 W ± 10%	A-B				
43	A/R		WIRE 22GA SOLID	ALPHA				
42	16		WASHER. NO.2 SPLIT LOCK	PHOS. BRZ.		NI-F		
41	16		SCREW, 2-56 x 1/4 LG BD.HD.	BRASS		NI-F		
40	2	TY-55X	TRANSFORMER	TRIAD				
39	1	TY-45X						
38	4	T-35X						
37	1	T-34X	TRANSFORMER	TRIAD				
36	2	FD100	DIODE	FAIRCHILD				
35	2	2N3905	TRANSISTOR	G.E.				
34	10	2N3903		MOT.				
33	2	2N696		TI				
32	4	2N404	TRANSISTOR	G.E.				
31	1	V500-337X9006S2	CAPACITOR, 330 MFD, 6V	SPRAGUE				
30	1	V500-476X9006B2	47 6V					
29	2	V500-226X9015B2	22 15V					
28	2	V500-105X9035A2	1 35V					
27	2	192P-10492	.1 200V	SPRAGUE				
26	4	5835-Y5U-1032	.01 25V	ERIE				
25	2	801-X5F-102K	.001 1KV	ERIE				
24	4	835X5V0502 Z	CAPACITOR, .005 MFD, 100 V	ERIE				
23	2		RESISTOR, 100Ω, 1/2 W 10%	A-B				
22	2		33Ω 1/2 W 10%					
21	1		82K 1/4W, 10%					
20	2		22K					
19	1		18K					
18	1		12K					
17	8		10K					
16	3		4.7K					
15	1		2.7K					
14	3		2.2K					
13	3		1.2K					
12	4		1K					
11	1		820Ω					
10	2		470Ω					
9	1		330Ω					
8	1		120Ω					
7	2		100Ω					
6	9		47Ω 1/4W, 10%					
5	2		5.1K 1/4W, 5%					
4	1		2K					
3	1		620Ω					
2	1		RESISTOR, 200Ω, 1/4W ± 5%	A-B				
1	1	N0733A	P. C. BOARD	FEC				

Figure 7-6. Parts List

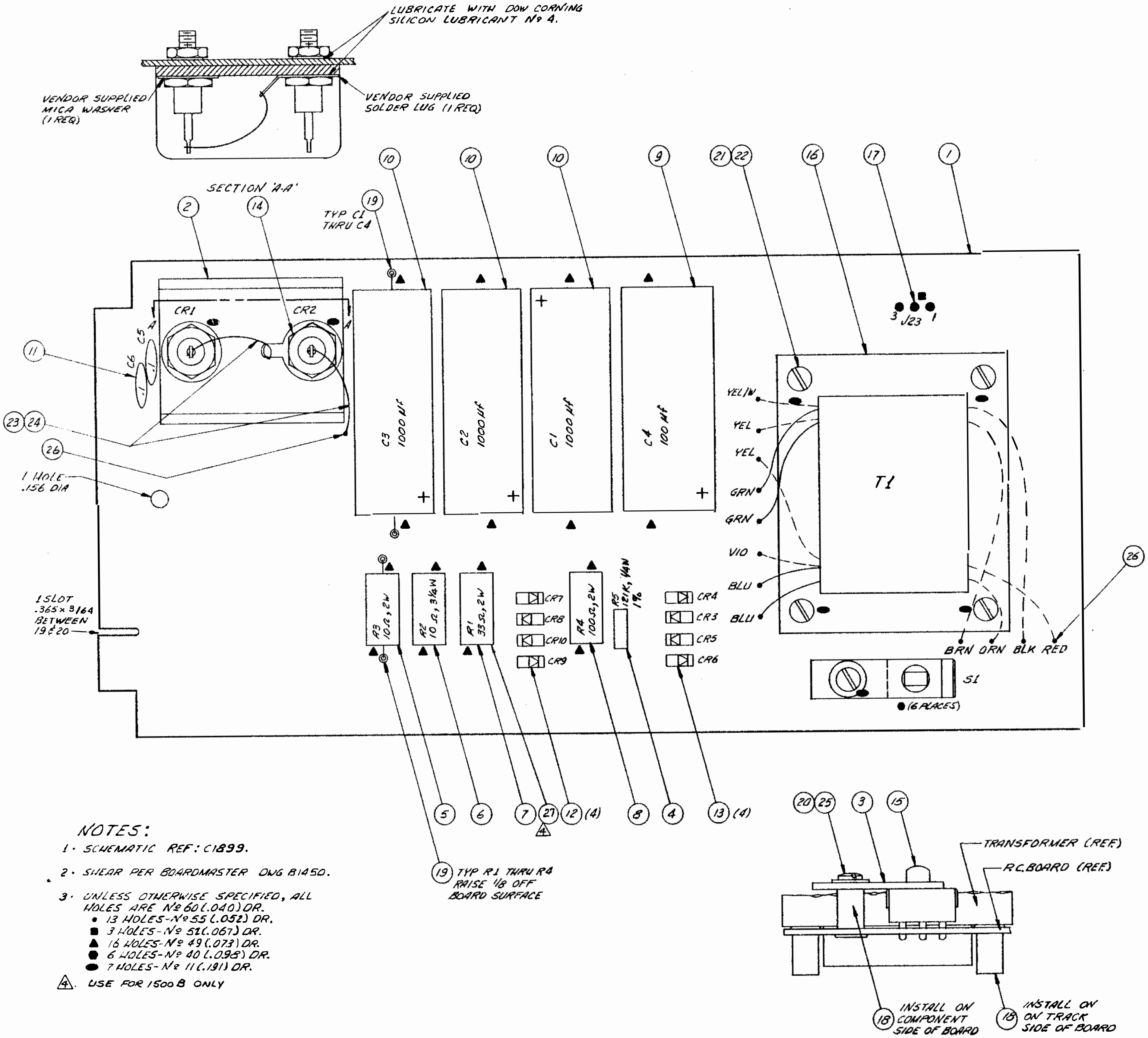
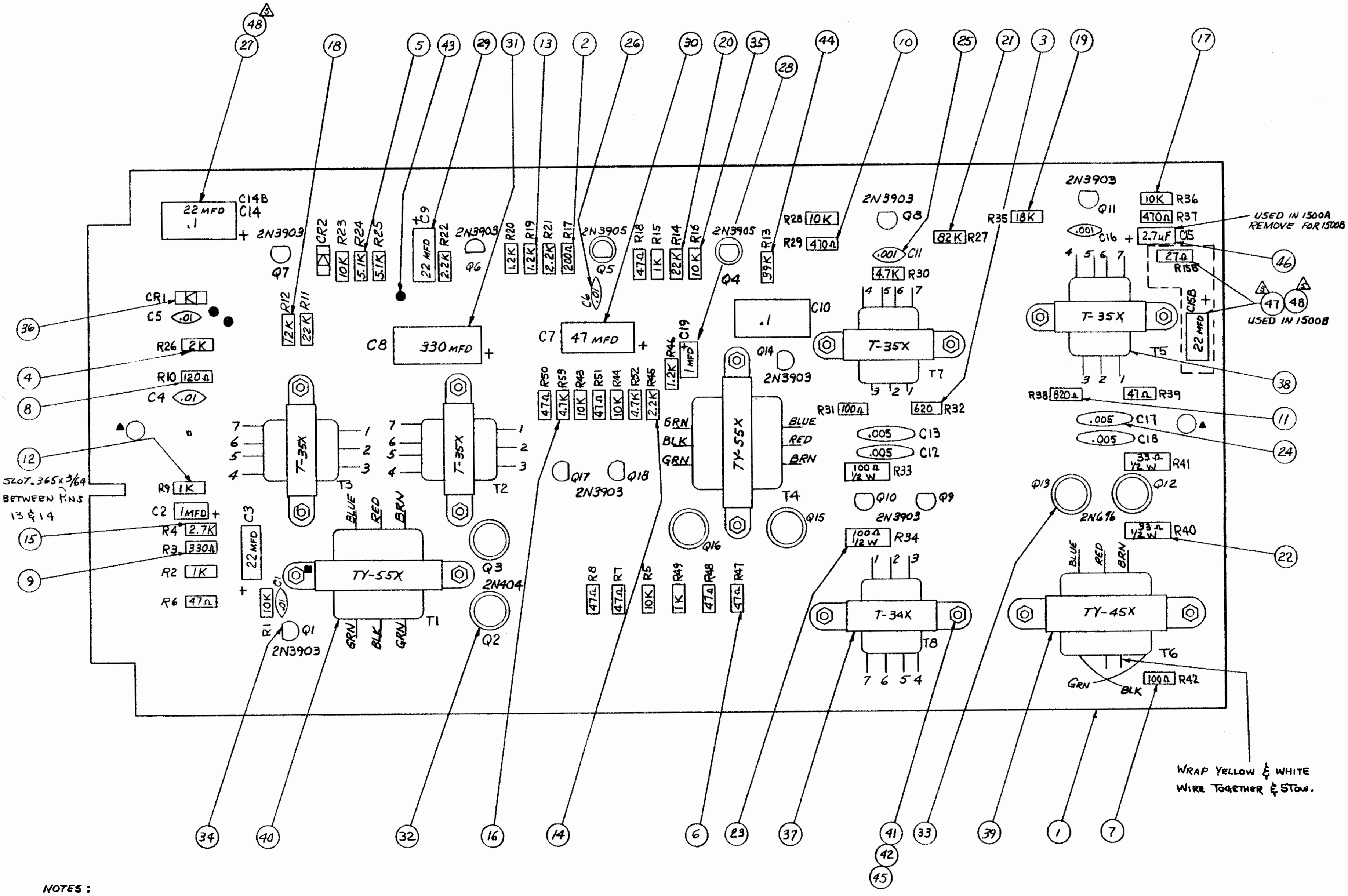


Figure 7-7. Power Supply, Board Assembly
N0724-J1-D1676E

ITEM	REQ'D	PART NO	DESCRIPTION	MAT'L OR MFR	MAT'L SPEC OR CAT. PART NO	FINISH	FINISH SPEC	CKT SYM
47	2	DM-15-240J	CAPACITOR, 24 PF. 500V 5%	ARCO.ELM.				
46	1	56064	EYELET	U.S.M.C.				
45	2		NUT, HEX. 2-56 x 3/16 AF	BRASS		NI-P		
44	2		WASHER, NO. 2 SPLIT LOCK	PHOS BRZ		NI-P		
43	2		SCREW, 2-56 x 1/4 LG. BD. HD.	BRASS		NI-P		
42	2	IMD-1-403J	CAPACITOR, .04 MFD, 100V, 5%	ARCO. ELM.				
41								
40								
39								
38	1	A466	TRANSISTOR	AMPEREX				
37	A/R		WIRE, 22 GA. SOLID	ALPHA				
36	2	6302	INDUCTOR 2.5mh. @200ma	MILLER				
35	3	80974	INDUCTOR 88 MH.	FEC				
34	2	8000-AG3	CRYSTAL, SOCKET	AUGAT				
33	1	9002.5KC	CRYSTAL. SEE NOTES	INT. XTAL	TYPE HA			
32	1	8997.5KC	CRYSTAL. SEE NOTES	INT. XTAL	TYPE HA			
31	1	2072	TRANSFORMER 10.7 IF	MILLER				
30	3	2N3662	TRANSISTOR	G. F.				
29	1		RESISTOR 330 Ω 1/4W ±10%	A-B				
28	4	2N3903	TRANSISTOR	MOT.				
27	2	DM-15-471J	CAPACITOR, 470 PF 500V 5%	ARCO. ELM.				
26	2	DM-15-251J	250 PF 500V 5%					
25	1	DM-15-470J	47 PF 500V 5%					
24	2	DM-15-100J	10 PF 500V 5%	ARCO. ELM.				
23	2	503-041-82P0-28R	5-20 PF 500V	ERIE				
22	2	150D-226X9015B2	22 MFD 15V	SPRAGUE				
21	2	150D-106X9020B2	10 20V	SPRAGUE				
20	1	150D-105X9035A2	1 35V	SPRAGUE				
19	1	IMD-4-504J	.5 100V, 5%	ARCO-ELM.				
18	1	IMD-1-253J	.025 100V, 5%	ARCO-ELM.				
17	2	IMD-1-153J	.015 100V, 5%	ARCO. ELM.				
16	9	5835-Y5U-103Z	.01 25V	ERIE				
15	3	801-X5F-102K	.001 1KV	ERIE				
14	1	835-X5V-502P	CAPACITOR, .005 MFD.	ERIE				
13	1		RESISTOR, 68 K, 1/4 W. 10%	A-B				
12	1		20 K 5%					
11	1		10 K 10%					
10	1		8.2 K					
9	1		5.6 K					
8	4		4.7 K					
7	3		3.3 K					
6	4		2.2 K					
5	4		1 K					
4	4		470 Ω					
3	4		220 Ω					
2	2		RESISTOR 100 Ω 1/4 W. 10%	A-B				
1	1	NO726B	P.C. BOARD	FEC				

Figure 7-5. Parts List



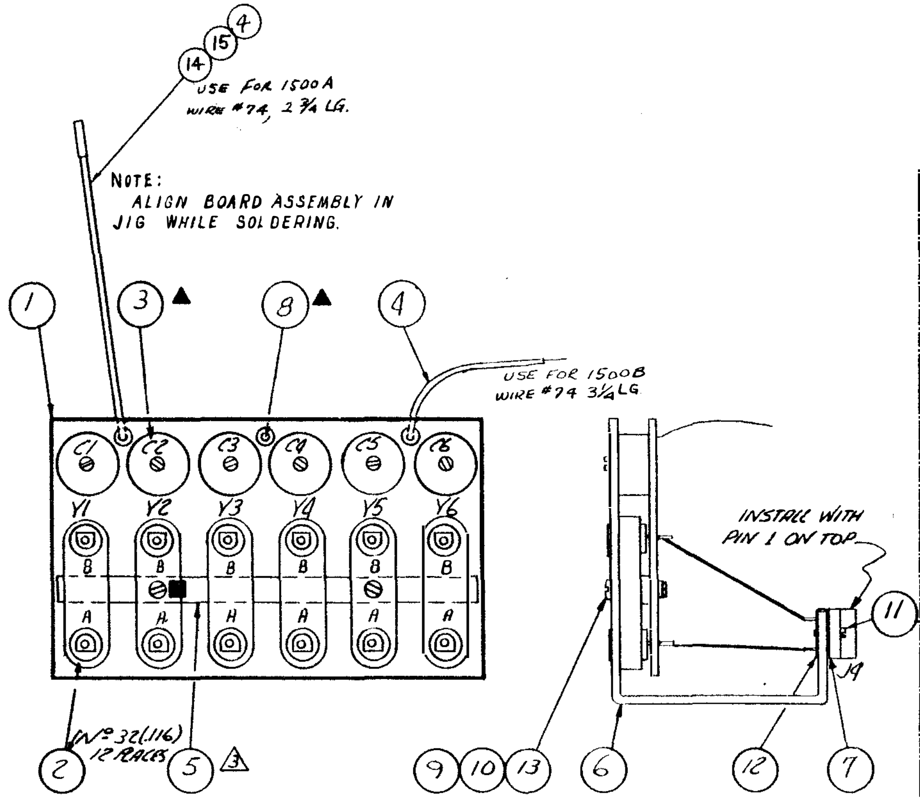
NOTES:
1. SCHEMATIC REF. D1670
2. UNLESS OTHERWISE SPECIFIED DRILL ALL MTG. HOLES #60(.040)
3. ▲ NO. 5/32 DR. (.156) 2 PLACES
4. ■ NO. 38 DR. (.101) 16 PLACES
△5 THIS PART USED IN 1500B, ONLY.

Figure 7-6. Audio And AGC, Board Assembly N0733-J3-D1671B

ITEM	REQ'D	PART NO	DESCRIPTION	MAT'L OR MFR	MAT'L SPEC OR CAT. PART NO	FINISH	FINISH SPEC	CKT SYM
△4 27	1	4361	RESISTOR, 10Ω, 3¼W, 5%	OHMITE				
26	13	S6064	EYELET	U.S.				
25	1		WASHER, Nº6 FLAT	SST				
24	A/R		TUBING, Nº 20 GA NATURAL	ALPHA				
23	A/R		WIRE, Nº 20 GA SOLID	ALPHA				
22	4		WASHER, Nº6 INT. TOOTH	SST				
21	4		SCREW, Nº 6-32 x 3/8 Bd. Hd.	SST				
20	1		SCREW, Nº 6-32 x 5/16 Bd Hd	SST				
19	16	2059	EYELET	STIMPSON				
18	5	1246-12	STANDOFF	CTC				
17	3	R62-3-ET	STAKE PIN, MALE	BEAD CHAIN				
16	1	TM1019	TRANSFORMER	TRANS. INC.				
15	1	G126	SWITCH, DPDT	C. WIRT				
14	2	1N1353A	DIODE, ZENER	MOT				
13	4	1N4004	DIODE	MOT				
12	4	1N4002	DIODE	ITT				
11	2	845X5V0104Z	CAPACITOR .1UF 100V	ERIE				
10	3	39D108G025GL4	CAPACITOR 1000 UF 25V	SPRAGUE				
9	1	39D107F250HL4	CAPACITOR 100 UF 250V	SPRAGUE				
8	1		RESISTOR 100Ω 2W 10%	AB				
7	1		33Ω 2W 10%	AB				
6	1	4361	10Ω 3¼W 5%	OHMITE				
5	1		10Ω 2W 10%	AB				
4	1	RN60D1213F	RESISTOR 121K ¼W 1%	AB				
3	1	B1173	SWITCH PLATE	FEC				
2	1	B1144-1	HEAT SINK	FEC				
1	1	N0724	P.C. BOARD	FEC				

LIST OF MATERIAL

Figure 7-7. Parts List



WIRING CHART

Y1-B	TO	H-1
Y1-A	"	H-A
Y2-B	"	H-2
Y2-A	"	H-B
Y3-B	"	H-3
Y3-A	"	H-C
Y4-B	"	H-4
Y4-A	"	H-D
Y5-B	"	H-5
Y5-A	"	H-E
Y6-B	"	H-6
Y6-A	"	H-F

USE 24 GA. BUS WIRE

NOTES

1. ▲ Nº 55(.052) DR. - 21 PLACES
   ■ 1/8(.125) DR. - 2 PLACES
2. CRYSTAL FREQ. DEPENDS ON CUSTOMERS REQUIREMENTS.
3. ALIGN HOLES ON SPACER (ITEM 5) WITH HOLES ON PC BOARD BEFORE SOLDERING CRYSTAL SOCKETS TO BOARD.
4. WIRE J1 (ITEM 7) PER WIRING CHART
5. SCHEMATIC REF D1674
6. DO NOT CLEAN THIS BOARD! BECAUSE IT REMOVES LUBRICANT ON ITEM 3.
7. DO NOT PUT BOARD IN HEAT.
8. REF SCHEMATIC D1882

ITEM	REQ'D	PART NO	DESCRIPTION	MAT'L OR MFR	MAT'L SPEC OR CAT PART NO.	FINISH	FINISH SPEC	CKT SYM
15	1	1625-1R	CONNECTOR	MOLEX				
14	1	1381TL	FEMALE PIN	MOLEX				
13	2		NUT Nº 4-40 x 1/4 AF		SST			
12	2	C15263-42-24	NUT Nº 4	TINNERMAN				
11	2		SCREW, SELF TAP Nº 4-40 x 3/8		SST			
10	2		WASHER, Nº 4 INT. TOOTH		SST			
9	2		SCREW, Nº 4-40 x 5/8 BH		SST			
8	3	56064	EYELET	US				
7	1	251-06-30-160	CONNECTOR	C-J				
6	1	B1451	CRYSTAL MTG BRACKET	FEC				
5	1	B1455	SPACER	FEC				
4	A/R		WIRE - 20GA. STR	ALPHA				
3	6	KOIOMA/60E	CAPACITOR, TRIM	AMPEREX				
2	6	05-0210-01	CRYSTAL SOCKET	ELCO				
1	1	Nº 736	PC BOARD	FEC				

Figure 7-8. Crystal Holder, Assembly
N0736-J4-C1900B

SECTION V

ALIGNMENT

5.1 GENERAL

The Model 1500A Receiver has been carefully aligned at FEC by trained personnel using precision test equipment. Alignment will be necessary only if the receiver has been tampered with or component parts have been replaced in the mixer and/or IF section (s). Before attempting any alignment of a malfunctioning receiver, always investigate and eliminate all other possible causes of the malfunction. It goes without saying that only qualified personnel should ever work on the receiver.

5.1.1 REQUIRED TEST EQUIPMENT

The following test equipment (or equivalent) is required to align the unit:

(a) Electronic Counter, Transistor Specialties, Inc. Model 373.
(b) AC Voltmeter, Hewlett-Packard Model 403B.
(c) RF Signal Generator, Clemens Mfg. Co. Model SG-83B.

5.1.2 INITIAL CONTROL SETTINGS

Initial settings of all front panel controls are listed below. Unless otherwise stated, these settings should be maintained throughout the alignment procedures.

POWER switch . . . . .ON
MONITOR LEVEL control . . . Half counterclockwise (approximately)
OUTPUT LEVEL control . . . .Maximum clockwise
RF GAIN control . . . . . . Maximum clockwise
AGC switch . . . . .As shown
OSC TRIM control . . . . . . .Center
CRYSTAL switch . . . . .R
BAND switch . . . . As shown
MHz control . . . . Approx. 9 MHz

5.1.3 ALIGNMENT PROCEDURES

Alignment procedures for the Receiver are presented in chart 1. On those occasions when it is necessary to replace mixer tube V1, the BFO and IF alignments will not be affected; therefore, only the mixer balance in part C must be performed. Whenever a complete alignment is necessary, all three parts must be performed in order beginning with part A.

Chart I. Alignment Data, Model 1500

Step	Generator Connections	Generator Frequency	Counter Connections	Voltmeter Connections	Band Switch	AGC Switch	Procedure
			A. BFO ALIGNMENT				
1			Common lead to chassis and input lead to base of Q5. Refer to figure 6-4.		C		On board N0726, adjust C4 for 9002.500 kHz reading on counter.
2			Common lead to chassis and input lead to base of Q6.		E		On board N0726, adjust C10 for 8997.500 kHz reading on counter. Remove counter leads and restore receiver to initial conditions.
			B. IF ALIGNMENT				
1	Connect to J20 on rear panel. (Common lead to chassis and input lead to center pin of J20.)	9000.000 kHz	Connect leads across SPKR terminals of TB1 (rear panel).		C	F	Adjust generator level for 0 dbm on S-meter. Obtain 9000.000 kHz signal by tuning generator for a 2.500 kHz reading on counter. Remove counter leads.
2	Same as in step 1 above.	Same as in step 1 above.		Connect lead across DEMOD terminals of TB1 (rear panel).	C	RMT	Adjust generator level for 0 dbm reading on voltmeter. *In the order given, adjust these components for maximum reading on voltmeter: (a) T1 (N0726) (b) C6 (N0727)